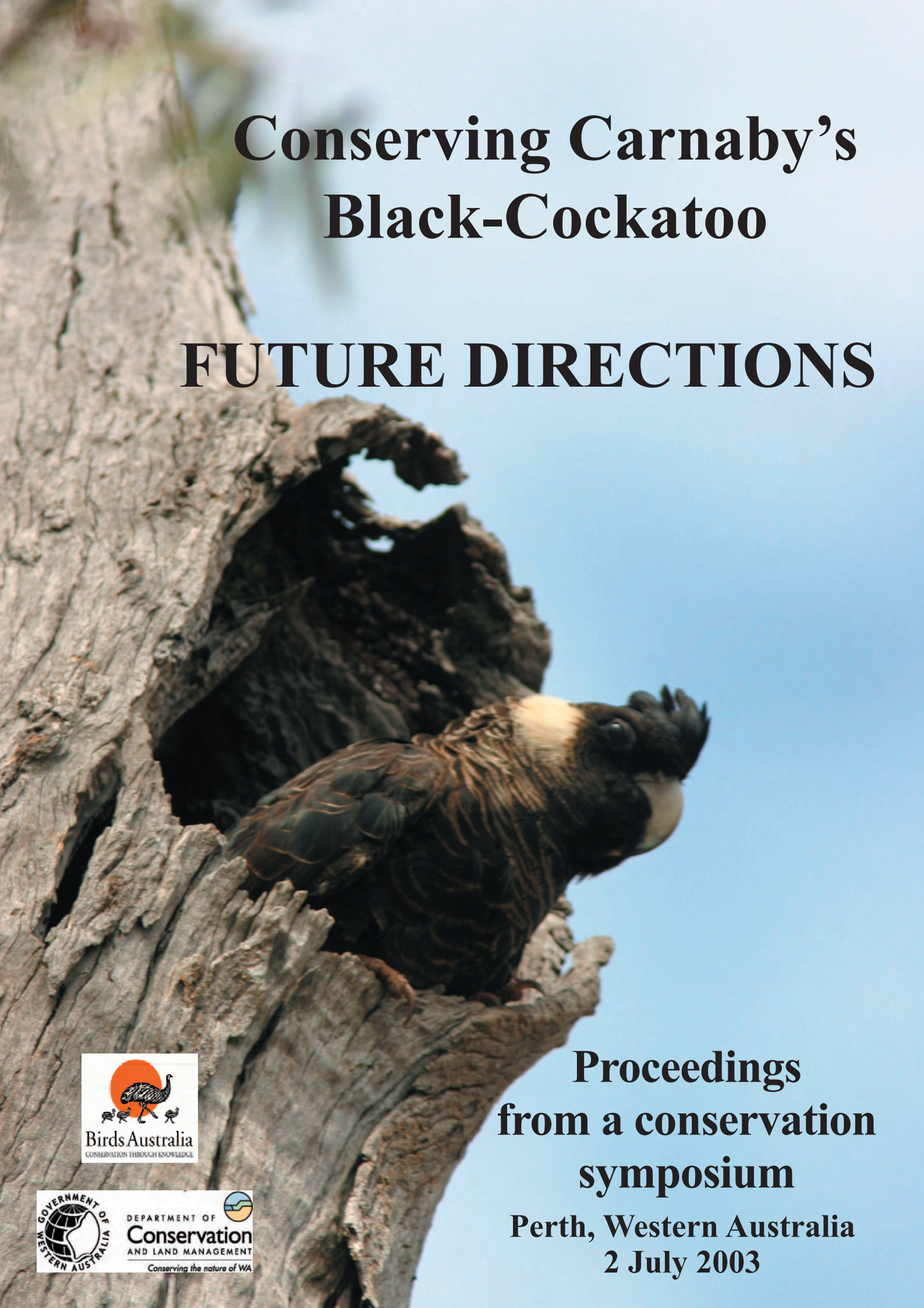

Conserving Carnaby's Black-Cockatoo

FUTURE DIRECTIONS

Proceedings from a conservation symposium

Perth, Western Australia
2 July 2003

Birds Australia
CONSERVATION THROUGH KNOWLEDGE

GOVERNMENT OF WESTERN AUSTRALIA
DEPARTMENT OF Conservation AND LAND MANAGEMENT
Conserving the nature of WA

Conserving Carnaby's Black-Cockatoo

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Editor

Cheryl Gole

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Female Carnaby's Black-Cockatoo *Calyptorhynchus latirostris* in nesting hollow

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Birds Australia WA, the Department of Conservation and Land Management and the Carnaby's Cockatoo Recovery Project were major contributors to the Symposium. We also acknowledge the important in-kind contribution made by CSIRO in provision of a venue and additional financial support provided by the Million Trees Program. The Million Trees Program acknowledges financial support from Rio Tinto's WA Future Fund and WWF-Australia's Threatened Species Network.

Denis Saunders travelled from Canberra to deliver a keynote address and share a wealth of experience with Symposium participants. We pay a tribute to his ongoing commitment to the conservation of Carnaby's Black-Cockatoo. We also thank the other speakers, some of whom also travelled long distances, who gave up their time to share their skills and knowledge. We thank the following presenters and co-authors: John Blyth, Mike Bamford, Denis Saunders, Peter Mawson, Rick Dawson, David Mitchell, Ron Johnstone, Phil Stone, Tony Kirkby, Caroline Minton, Stephen Davies, Leonie McMahon, Peter Stubbs, Mick Davis, Fiona Falconer, Alison Doley, John Young and Sarah Mason.

Much assistance was provided by volunteers from Birds Australia WA. Ruth Greble and Stella Stewart Wynne administered registration and Cynthia Munday and Phyllis Bentley assisted with the production and collation of Symposium materials. Rick Curtis and Rob Mather provided assistance with parking and setup tasks. Sarah Crook undertook to produce the displays and Robert Davis took photographs. Lyn Atkins (CSIRO) and Allan Burbidge (CALM) provided assistance with audiovisual aids throughout the day. Jill Pryde (WA Threatened Species and Communities Unit) provided additional administrative support. Registered carer Yvonne Varris provided a live Carnaby's Black-Cockatoo (in cage) to enliven the proceedings.

The distribution of the Proceedings in print and on CD has been made possible through the efforts of Leonie McMahon, Ruth Greble and Liz Walker. Susan Tingay drew the Carnaby's Black-Cockatoo on page 2 and the Proceedings CD label was designed by Sarah Horton with the assistance of Margaret Phillipson.

To all, our grateful thanks.

Cheryl Gole, Leonie McMahon and John Blyth

Symposium organisers

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Conserving Carnaby's Black-Cockatoo Future Directions Symposium: An Overview

Cheryl Gole
Birds Australia WA

The Carnaby's Black-Cockatoo: Future Directions Symposium was initiated through the Carnaby's Recovery Team and jointly organised by Birds Australia WA, the Department of Conservation and Land Management and the Carnaby's Cockatoo Recovery Project. The purpose of the Symposium held on 2 July 2003 was to bring together a range of stakeholders involved in research, conservation, land management and other activities of relevance to conservation of the Cockatoo. The Symposium also acknowledged the increasing levels of interest and involvement in Carnaby's Black-Cockatoo conservation issues in the community.

The Symposium had a number of aims. Broadly, these were to inform stakeholders of the range of conservation and research activities being undertaken and to identify gaps in current research and conservation activities. It also sought to disseminate existing knowledge of the Cockatoo and provide networking opportunities for stakeholders.

In the introductory session to the Symposium, John Blyth and Mike Bamford contextualised the role of two key stakeholders in Carnaby's Black-Cockatoo recovery actions. John Blyth provided an outline of the role of the Department of Conservation and Land Management and its statutory requirements in relation to threatened species recovery. He also outlined the major types of recovery actions documented in the Recovery Plan for the Cockatoo. In his introductory and welcoming speech, Mike Bamford described Birds Australia's role as Australia's oldest conservation organisation, a largely voluntary non-government organisation with a long history of linking birdwatchers and conservation activities through community-based activities.

The Symposium's keynote address opened the session on research and conservation issues. Dr Denis Saunders is a well-known scientist whose research on Carnaby's Black-Cockatoo from the late 1960s through to the late 1990s oversaw a change in status for the species from vermin to endangered species. His work demonstrated that clearing for agriculture was and is a significant factor in the species' decline due to the loss and fragmentation of wheatbelt habitat critical for nesting and feeding. The future for many vegetation remnants of critical importance to the Cockatoos is bleak unless degrading trends can be reversed. Denis's research provides baseline data on which much current research and conservation work relies.

In their papers contributing to the research and conservation session of the Symposium, Peter Mawson, David Mitchell, Ron Johnstone and Stephen Davies provided an overview of the issues affecting Carnaby's Black-Cockatoo survival and research and conservation activities being undertaken for the Cockatoos' recovery. DNA fingerprinting is now employed to address poaching of Carnaby's Black-Cockatoos along with the close monitoring of captive stocks of the species. The extensive pine plantations in Gnangara Park in Perth's northern metropolitan area are believed to be a very significant food source for the northern populations of Carnaby's Black-Cockatoo. The planned staged removal of the pines poses a number of conservation and management questions, and these are explored in David Mitchell's paper in this volume. Ron Johnstone summarises decades of records from the Western Australian Museum to provide information related to the distribution and food sources of both white-tailed black-cockatoos inhabiting the southwest of the state, Baudin's and Carnaby's Black-Cockatoos. Lastly, Stephen Davies describes the results of several years of community revegetation efforts to provide food and nest sources for the Cockatoos in the Moore Catchment and outlines new research that endeavours to answer questions related to the use by Carnaby's Black-Cockatoo of artificial nest boxes.

In a paper that links conservation and research work with on-ground activities, Leonie McMahon describes the Birds Australia Carnaby's Black-Cockatoo Recovery Project and its work, primarily in the northern agricultural area of WA. Under the guidance of the project and the Recovery Team, community groups undertake revegetation and monitoring activities that will be critical to the species' survival in these important breeding areas. Leonie also describes the problems of securing reliable and on-going funding for recovery work and the challenges brought about by dealing with a public increasingly interested in the welfare of the cockatoo.

Accounts of recovery actions where they really count – on the ground – occupied the Perspectives from the Bush session of the Symposium. In an inspiring set of presentations, Peter Stubbs, Mick Davis, Fiona Falconer, Alison Doley, and John Young and Sarah Mason outlined the ways in which conservation work undertaken by rural shires such as Moora, farmers such as the Doleys, and programs such as Woodland Watch, Land for Wildlife and Cockys for Landcare implement and complement important recovery actions.

The Symposium closed with a session in which the future direction of research and conservation work for Carnaby's Cockatoo was broadly outlined by the identification of gaps in current research work and recovery actions. This will provide a framework that, together with the existing Recovery Plan, will inform future conservation directions for the Cockatoo.

The Future Directions Symposium provided an opportunity for a range of stakeholders to contribute to overall knowledge about Carnaby's Black-Cockatoo. One hundred and ten people, ranging from landholders and community groups to representatives from non-government organisations, local government and state agencies travelled from many parts of the southwest of Western Australia to share insights into the conservation issues facing the survival of one of the state's endemic birds. The published Proceedings provide a permanent record of the work that continues to underpin Carnaby's Black-Cockatoo recovery.

The Carnaby's Black-Cockatoo Recovery Program

John Blyth
Western Australia Threatened Species and Communities Unit,
Department of Conservation and Land Management

Introduction

This paper is intended to provide an introduction to the Carnaby's Black-Cockatoo Future Directions Symposium. In it I outline briefly:

- the aims of the symposium;
- the Department of Conservation and Land Management's (CALM's) responsibilities and role in the conservation of biological diversity in general and how the recovery of threatened species fits into that role;
- the recovery process as it is applied to threatened species;
- the recovery plan for Carnaby's Black-Cockatoo;
- progress with implementation of the recovery plan;
- and finally, a few points we might need to consider when discussing future directions.

Many of the matters discussed briefly in this paper are covered in much more detail elsewhere in these Proceedings.

Aims of the Symposium

1. To bring together and present existing knowledge about Carnaby's Black-Cockatoo;
2. To clarify the aims and activities of the Carnaby's Black-Cockatoo Recovery Team, and the use by the team of standard recovery procedures;
3. To show the links between knowledge and actions on the ground, and improve access to important information for managers;
4. To provide opportunities for networking and sharing information and experiences between all people involved in assisting the recovery of this species;
5. To assess our effectiveness in recovering Carnaby's Black-Cockatoo, and identify improvements that can be made to the recovery program.

CALM's responsibilities for the conservation of biological diversity

CALM's responsibilities in relation to the conservation of biological diversity stem from the *Western Australian Wildlife Conservation Act 1950*, the purpose of which is to conserve and protect wildlife. Protecting wildlife is now seen as synonymous with conserving biological diversity and preventing the extinction of indigenous species. In order to fulfill the responsibilities arising under the Act the Department has various roles, largely concentrated on four major areas of activity.

1. The establishment and management of a *comprehensive* (all elements of biodiversity being represented), *adequate* (representation of each element sufficient to be self-sustaining) and *representative* (typical examples of each element being present) reserve system. This task involves three main parts:

- the identification of biological diversity across Western Australia and within recognized biogeographic regions by systematic biological survey;
- the acquisition, by purchase on the open market of freehold land or pastoral leases, or the change of management arrangements or vesting of land already owned by the Crown, of key areas for the reserve system;
- management of the conservation reserve system to reduce the impacts of threatening processes and maintain the area's biological diversity.

2. Alleviating threatening processes across the landscape. Examples of the approach to this activity are provided by the Department's involvement in the State Salinity Strategy and by the Western Shield program:

- The State Salinity Strategy is funded by both State and Commonwealth Governments. CALM has completed a major biological survey of the south-western agricultural area, is the lead agency for the identification and recovery of biodiversity recovery catchments, and receives considerable extra resources for managing conservation reserves in areas threatened by salinity;
- Western Shield is a CALM initiative to aid in the recovery of threatened ground-dwelling fauna by controlling feral predators. Fox control is now a major activity and has allowed the recovery of significant numbers of many medium sized mammals and their reintroduction to many places from which they had been extirpated. Research on cat control is almost at the stage where broad-scale operational application is possible.

3. Off-reserve conservation has three main elements.

- Voluntary programs: these include the Land for Wildlife Scheme, the covenanting scheme, and the Roadside Conservation Committee;
- Partnerships, public appreciation and support: this department-wide activity is designed to provide publicity and education programs, to promote partnerships between the Department and other sectors of the community, and to encourage sympathy and support in the general public for the aims of biodiversity conservation;
- Assessment and regulation: the Department provides advice to government on biodiversity issues, especially in relation to the assessment of proposed developments. CALM is also responsible for advising and regulating various industries using biological resources, such as beekeeping, the wildflower industry and aviculture.

4. Threatened species and ecological communities. This responsibility is discussed in the following section.

The recovery process

The recovery process is an internationally accepted set of procedures for dealing with threatened species and ecological communities and has several essential elements. I deal here only with threatened species, and the process is outlined below.

- The conservation status of one or more species is reviewed, taking into account all relevant biological, ecological and distributional knowledge. This may be via a national review of a major group, such as the *Action Plan for Australian Birds* (Garnett & Crowley, 2000) or it may be for a single species, resulting from information provided by a particular person or group;

- Based on the review, one or more species is nominated to the State Threatened Species Scientific Committee for listing as threatened. This committee, with wide expertise in conservation biology, then assesses the nominated species against rigorous international criteria, developed and maintained by the International Conservation Union (IUCN). Species recommended to the Minister for the Environment for listing as threatened under the *Wildlife Conservation Act 1950* will be in one of three recommended categories: Critically Endangered CR, Endangered (EN) and Vulnerable (VU). An indicative time to a 50% or more likelihood of extinction if current declines are not halted is around ten years for CR taxa, around 20 years for EN and around 50 years for VU;
- Once a species is listed, more research may be necessary to clarify the steps needed to bring about its recovery.
- A recovery team, made up of people who can contribute to the recovery of the threatened species, is established, and coordinates the recovery process from this step forward;
- A recovery plan is written, and the recovery team usually coordinates its writing. The plan lists recovery actions, costs, responsibilities and measurable criteria for success in sufficient detail to ensure successful implementation;
- The recovery team is then responsible for implementing actions within the recovery plan, for ensuring that the results of actions are monitored and recorded, and that progress in implementing the recovery plan is reviewed annually and reported to CALM;
- Finally, at the nominal end of its life (usually ten years for a full recovery plan and five years for an interim recovery plan) the need for continuation, modification or replacement of the plan is addressed in the light of the criteria listed in the plan.

The Recovery Plan for Carnaby's Black-Cockatoo

The Carnaby's Black-Cockatoo Recovery Plan is for ten years. The Plan presents background biological, ecological and distributional information about the Cockatoo, largely based on the research of Denis Saunders from the late 1960s to the late 1990s.

Carnaby's Black-Cockatoo is currently ranked as Endangered, meeting IUCN criteria for that category, and is listed as threatened under both the State *Wildlife Conservation Act 1950* and the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*. The assessment as Endangered is based largely on loss of feeding and breeding habitat throughout much of its original range and the fact that, to the end of Denis Saunders' research, numbers of birds at his study sites were still declining. The key threatening process -loss of feeding and breeding habitat - is still occurring, as is illegal taking by shooting or for the aviary trade.

Recovery actions in the Recovery Plan are of five major types:

Carnaby's Black-Cockatoo: progress with recovery

A ten year recovery plan for Carnaby's Cockatoo has been written and the recovery team is in place. In draft form the recovery plan has been providing the direction for recovery actions during the last three years. Considerable progress has been made with most of the five main types of actions discussed in the last section, and details are provided elsewhere in these Proceedings.

In summary, our understanding of the status and needs of Carnaby's Black-Cockatoo is continuing to increase, considerable positive management is in train for both breeding and feeding sites, and public support, especially from all-important landowners, is growing rapidly.

Given the recent identification by Ron Johnstone (WA Museum) and his team of a large shift in the distribution of Carnaby's Black-Cockatoo towards the coast, and the successes in

management and public support, there is room for cautious optimism about the future of this flagship species.

Future directions

This is considered in the last section of these proceedings but as an introduction there are three points that can be made. First, it is clear that continuing and increased public support, in both rural and metropolitan areas, will be essential for the successful recovery of this species. Secondly, it is important for us to clarify the apparent shift in distribution of Carnaby's Black-Cockatoo. We need to understand whether this shift consists simply of birds displaced from the wheatbelt that are now breeding in coastal areas, or whether this breeding is now allowing the overall population to begin expanding again. Finally, we need to remember that for a bird as long-lived as Carnaby's Black-Cockatoo (with a life-span probably more than 30 years), the recovery program will need to be maintained for many years before we see a significant response. It may well take 30 years of recovery actions before we can be confident that the species' status has really improved.

Photo: E. Adams

Female Carnaby's Black-Cockatoo in nesting hollow.

Birds Australia WA: Its Role in Conservation Projects

Mike Bamford
Birds Australia WA

Birds Australia Western Australia is a regional branch of Birds Australia, formerly known as the Royal Australasian Ornithologists Union, by which name it is still registered in Victoria. Ornithologists study birds, and that is what Birds Australia is about. It is not a bird-watching club, however, although many of its members are bird-watchers; it is a conservation and research organisation that works through a unique combination of amateurs and professionals. The organisation has a national office in Melbourne, regional offices in WA and New South Wales, regional groups in most states and members around the world. The national office is the only facility with permanent staff; other offices rely on volunteer committees with employees paid to coordinate specific projects.

Birds have tremendous appeal to the broad community and Birds Australia uses this appeal to learn about and conserve Australian birds and their environment. The appeal of birds gives Birds Australia a proportion of its membership that are not active bird-watchers and who are not involved in projects, but who like birds and like to support an organisation that aims to look after birds. This may eventually become the largest proportion of the membership, as has happened with similar organisations in England, the Netherlands and North America. The active membership consists of people who may consider themselves to be amateur bird-watchers or professional ornithologists, but who are united by an interest in birds and a desire to conserve them. The amateurs are often the better bird-watchers and bring to the organisation a myriad of skills. The professional ornithologists ensure the quality of science carried out by the group.

Birds Australia started life in 1901 as a union (in the true sense of the word) of amateur ornithologists. This was a time when scientific disciplines such as ornithology and ecology were virtually unheard of. The initial goal was simply to learn about birds in what was then a new nation, but conservation soon became important, initially to bring about an end of the mass destruction of egrets whose breeding plumes were collected to adorn the hats of Edwardian ladies. The organisation was in existence as ornithology became a science, which is perhaps why Birds Australia took on a scientific role but retained and has encouraged non-professionals in its membership.

But what does Birds Australia and its members do? In general, the organisation carries out projects that makes best use of its membership. Some of these projects rely heavily on scientists and other skilled participants, such as the publication of the seven volume *Handbook of the Australian New Zealand and Antarctic Birds*, a milestone series that collates much of what is known about birds in our region. This will provide a benchmark for future research for decades if not the next century. Other projects rely on a broad membership base, such as the two Atlases of Australian Birds, in which bird-watchers, including non-members, are encouraged to turn their bird-watching into science by systematically recording the birds seen. The cost-effectiveness of using skilled volunteers (thousands of them in the case of the Atlases) coordinated by a core of paid staff has been proven repeatedly by Birds Australia.

Projects on a grand scale, such as the Atlases, are run on a national level, often through the office in Melbourne but sometimes with coordinators in the regions. Regional groups, however, and Birds Australia WA leads the way in this respect, also run research and conservation projects. These may be as small and localised as counting birds on a single wetland or as large as coordinating surveys of a threatened species across half the state. Projects organised by regional groups are overseen by a regional conservation and research committee and must meet the standards of the national body. Currently in Western Australia, the national Atlas continues while there are regional projects on Carnaby's Black-Cockatoo, the Hooded Plover, Western Ground Parrot, birds in urban local government reserves and waders.

In addition to research activities, Birds Australia WA and Birds Australia overall also function in a similar manner to other conservation organisations, commenting on development proposals and providing submissions on issues, lobbying government agencies and so on. Importantly, Birds Australia does this both from the position of a respected research organisation and from the position of representing a broad membership base. Many of those members pay their membership fees not because they want anything back from the organisation in the form of a magazine or organised bird walks, but because the organisation can do the sorts of things in research and conservation that an individual cannot.

Because Birds Australia is about the conservation of birds, rather than simply bird-watching, it is about people as well as about birds; and the symposium was a good example of this duality. When asked for a show of hands, virtually all of the 110 or so people at the Carnaby's Black-Cockatoo Symposium happily admitted to being there at least partly because they had fond memories of the bird. Carnaby's Black-Cockatoo is big, noisy, spectacular, occasionally destructive; and a creature you don't forget in a hurry. Memories of Black-Cockatoos are the sort of thing that enrich childhood; they are a part of what it means to live in this corner of the world. Birds in general do that in a way that few other animals can. The role of Birds Australia is to use the unique composition of its membership to ensure that people's lives can continue to be enriched by birds; and that birds can continue to exist in a world increasingly dominated by people.

Conserving Carnaby's Black-Cockatoo: Historical Background on Changing Status

Denis Saunders
CSIRO Sustainable Ecosystems

I joined CSIRO early in January 1968 to work on the ecology of what was then known as the White-tailed Black Cockatoo *Calyptorhynchus baudinii*. Prior to this, limited research had been conducted on the bird. The species had been the subject of taxonomic speculation with Ivan Carnaby (1948) being convinced that the bird from the Lake Grace district was "a good subspecies" of the bird of the southwest forests. Dick Perry (1948) had written of their impact on pine plantations, and in the late 1950s, Stephen Davies (1966) had started a research project, which was effectively a scoping study for the full-time study I was appointed to conduct from 1968. This study was initiated by CSIRO because the species was regarded as a pest in pine plantations and apple and pear orchards. The problem in pine plantations arose because the bird often chewed off the leader of growing pine trees, resulting in bent trunks; something of an economic loss of sawn timber. The problem in orchards was that they ate the seeds of apples and pears, damaging commercial crops in the process.

My joining CSIRO and being handed the black cockatoo study started a love affair with an animal it has been a dream to work on. It was soon apparent that, as posited by Ivan Carnaby, there were two taxa of black cockatoos with white tails. The early work consisted of establishing the taxonomy of the white-tailed black cockatoo complex and then comparing them with the closely related yellow-tailed black cockatoo *Calyptorhynchus funereus* complex.

This research revealed that a white-tailed black cockatoo *C. baudinii* with a long bill occurred in the forests of the southwest and this bird was responsible for the damage to apple and pear orchards. This was initially known under the cumbersome common name of long-billed white-tailed black cockatoo, but is now known as Baudin's Black-Cockatoo.

Based on morphometrics and ecology, the other cockatoo with a white tail was separated from it and was initially regarded as a subspecies (Saunders 1974) but was later regarded as more closely related to the yellow-tailed black cockatoo complex and was known as the Short-billed White-tailed Black Cockatoo *C. f. latirostris* (Saunders 1979), but is now known as Carnaby's Black Cockatoo and is regarded as a species in its own right (*C. latirostris*). This is the bird responsible for the damage to pines. The birds are the same size and weight, show the same colour patterns and sexual dimorphism, but differ in length of bill (Figure 1), calls and diet.

Figure 1: Skulls of Carnaby's (top) and Baudin's Black-Cockatoos showing the difference in shape of the bills.

It was only possible to study the ecology of one taxon in detail. I would like to say that the choice of taxon was made as a result of a benefit-cost analysis based on perceived problems posed by the birds. However, the choice was much more pragmatic, but was relatively simple for me. I am afraid of heights. Carnaby's Cockatoo breeds in the area receiving between 650 and 300 mm of annual rainfall and the trees are very much lower there (5-7 metres above the ground) than in the more mesic forests of the southwest where Baudin's Cockatoo breeds in trees which are 30 metres or more.

During the life of the project, research, particularly breeding behaviour and ecology, was conducted at five study areas that covered a considerable range of the bird's distribution. These were at Nereeno Hill, Coomallo Creek, Manmanning, Tarwonga and Moornaming (Figure 2).

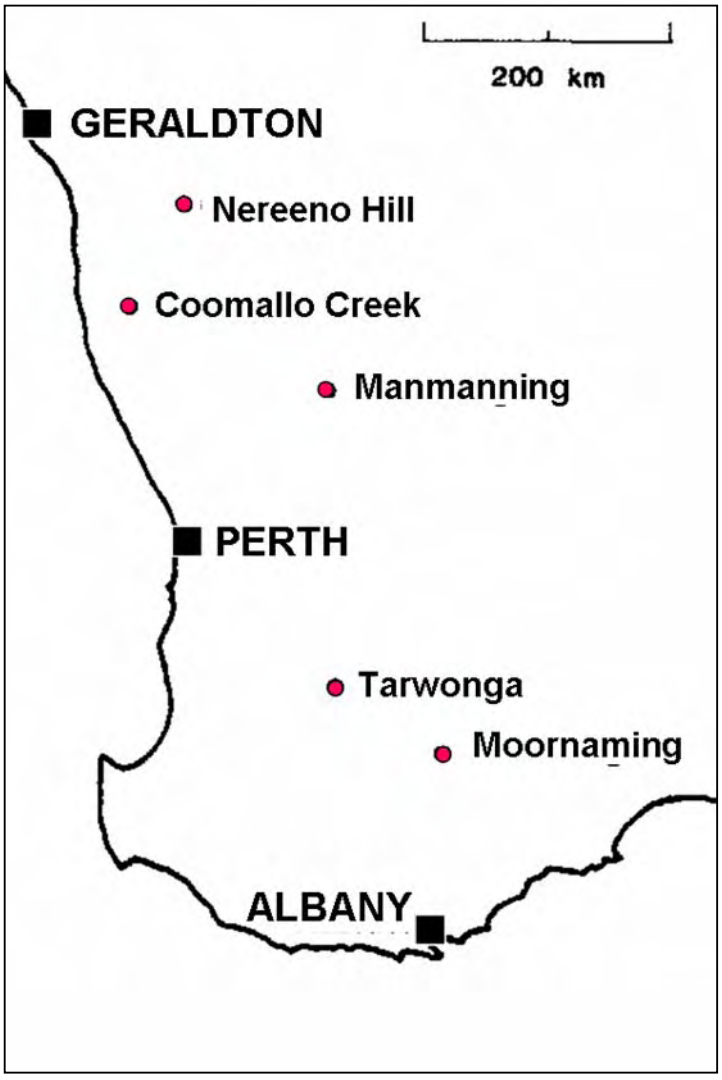

Figure 2: Locations of the Carnaby's Black-Cockatoo study areas.

Birds were marked with individually recognisable wing tags to facilitate behaviour studies and to establish movement patterns. The populations at Manmanning and Coomallo Creek were studied in particular detail. These studies were based on visits to these areas at weekly intervals throughout the breeding seasons of 1970 to 1976 (Saunders 1982). During these visits attempts were made to locate every nest site, tag all the breeding adults and measure and tag every nestling after they were three weeks old. The other areas were visited opportunistically, but not with the same regularity.

The choice of Coomallo Creek and Manmanning for detailed studies proved to be excellent. The former area had more than 70% of its native vegetation remaining at the start of the study, although clearing was still taking place as properties were being developed for agriculture. The latter had less than 9% of native vegetation remaining, and clearing had stopped some years before the study commenced.

A large volume of data was generated by this work and individual birds provided many useful insights into their biology. For example, female UM had a large nestling and was seen feeding the day before a wedge-tailed eagle (*Aqila audax*) killed her and fed her to its chicks on a nest at Coomallo Creek (Figure 3). On finding the remains of her carcass and both her wing tags on the nest, we then concentrated our attention on her mate and, over several weeks, watched him

fledge the nestling and rear it. We saw him a number of times over several years and although he took another mate and bred with her, he was seen with UM's nestling a number of times over several years. Each time he was obviously associated with his offspring, who was a young male.

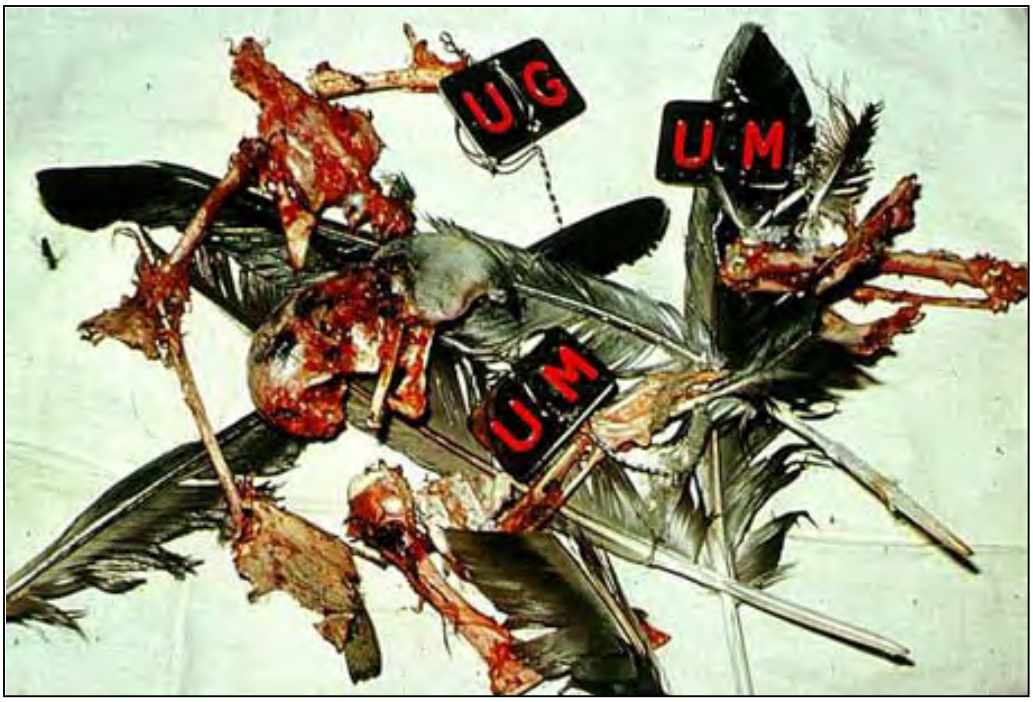

Figure 3: Remains of two female Carnaby's Black-Cockatoos (UM and UG) from a Wedge-tailedEagle's nest at Coomallo Creek.

As a result of individually marking the birds, we knew who bred in the study areas, who they had bred with, their nesting success and could predict with reasonable accuracy the areas they ranged over. Using the population of Coomallo Creek as a test, over two years we predicted where they would go during the non-breeding season and set out to find them. We found 63% of our tagged breeding females and 75% of our tagged breeding males in a radius of about 40 km around their breeding area. As a result we could produce a map of which feeding and watering areas were critical for the survival of the population (Saunders 1980) (Figure 4). These results were used to justify the acquisition of a long, narrow reserve along the Hill River, to the southwest of Coomallo Creek.

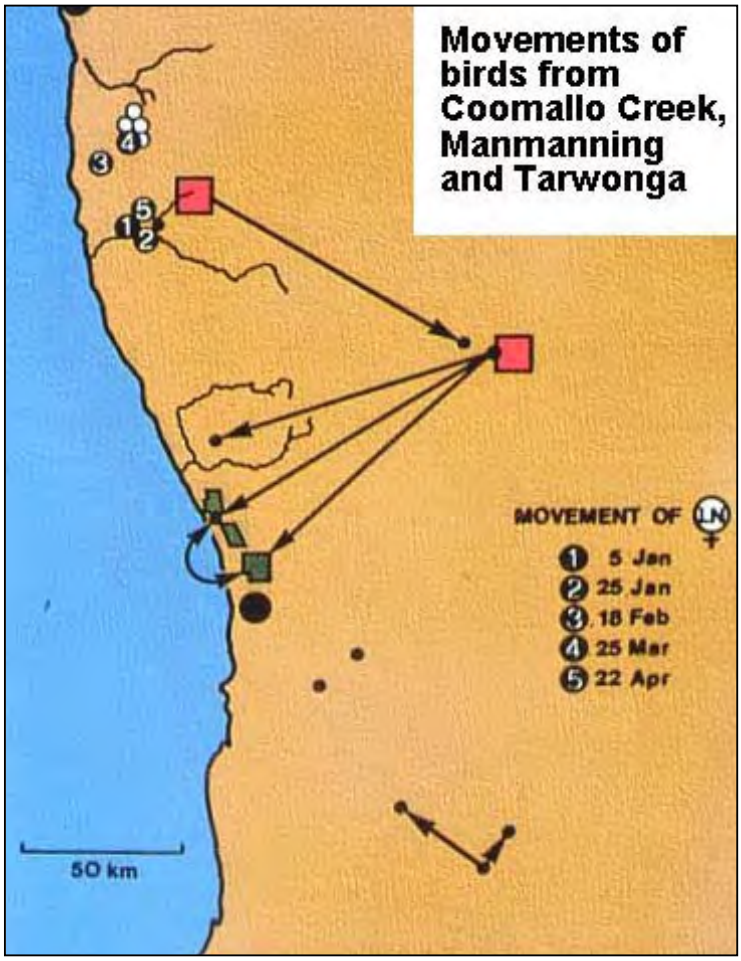

Figure 4: Movements of tagged birds from Coomallo Creek , Manmanning and Tarwonga.

Although detailed studies of Carnaby's Cockatoo ceased in 1978, monitoring of the Coomallo Creek population continued. The monitoring protocol was designed by examining the early data based on weekly visits and selecting the most appropriate times to visit the area to maximize observations with the least effort. This worked out to involve visiting the area twice during each breeding season; once in the first half of September and the other in the middle of November (Figure 5). During each visit nest hollows were checked and new ones searched for. Any nestlings were measured and banded and attempts were made to find out which females were breeding in the area.

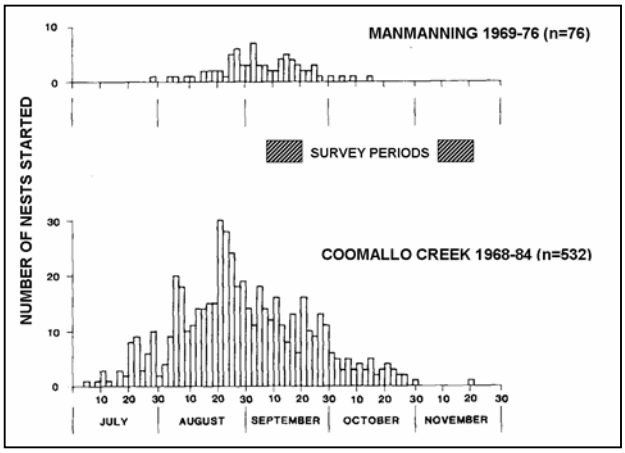

Figure 5: Comparison of numbers of nests for Carnaby's Black-Cockatoo at Manmanning and Coomallo Creek.

Nestlings can be aged accurately using the length of the folded left wing (Figure 6) and comparing that measurement against a growth curve based on measurements from nestlings of known age (Figure 7). The weights of these nestlings can then be compared against a weight for age chart based on 246 nestlings to see if they fall within the normal range.

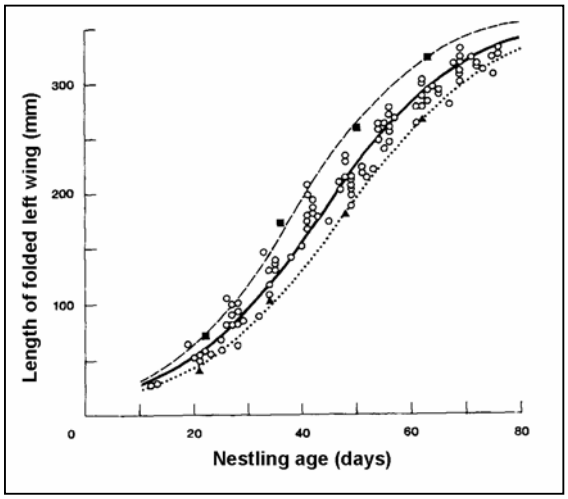

Figure 6: Aging of Carnaby's Black-Cockatoo nestlings using folded wing measurements.

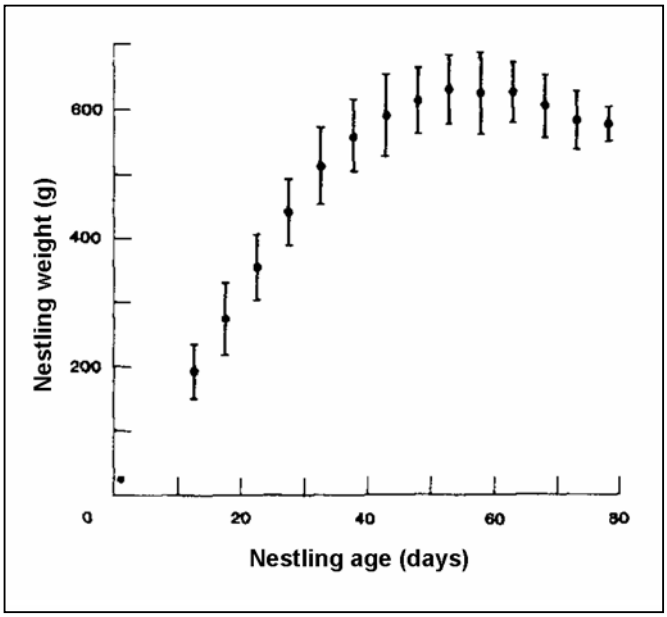

Figure 7: Growth curves of Carnaby's Black-Cockatoo chicks based on measurements from nestlings of known age

Examining the data for nestling weights from all five study areas, the problems of the birds at Manmanning were obvious (Saunders 1986). Many of the nestlings were underweight and the population was having problems supplying sufficient food to rear their young successfully. In fact, it was only the birds that bred early in the season who had any chances of fledging a nestling. In 1972, only one pair out of 14 successfully fledged a chick. As a result of these problems of food shortages, the population had died out by 1978. The population at Nereeno Hill was showing the same trends and the populations at Tarwonga and Moornaming may have been experiencing some food shortages (Figure 8).

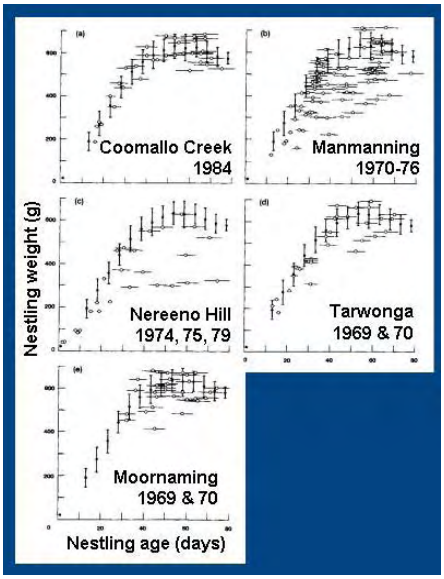

Figure 8: Weights of Carnaby's Black-Cockatoo nestlings compared with those of known-age nestlings at Coomallo Creek, 1970-76.

The results of this research showed clearly that Carnaby's Black-Cockatoo was having breeding problems over some of its range (Saunders 1990). However, because it is a very long-lived and sociable species which forms flocks, particularly during the non-breeding season, the effects of this lack of breeding success were not immediately apparent. Fortunately, a survey of the distribution of the species was conducted in 1968. This was done with the support of the Education Department of Western Australia, who allowed all the schools in the southwest to participate in a survey, aided by the Gould League. Questionnaires were sent to 244 schools and completed forms were returned by 84%, allowing a distribution map to be drawn up. Between 1987 and 1990 a major atlas of birds of the Western Australian wheatbelt was conducted (Saunders and Ingram 1995). Unfortunately, the methods used in1968 could not be repeated because it would only show the contraction in range of Government schools in south-western Australia and not necessarily a change in distribution of Carnaby's cockatoo. Over the years nearly all of the small schools have closed and children are now bussed to the bigger centres where schools are now located. Despite the different survey methods, a comparison of the distribution map of 1968 with that of the period 1987 to 1990 shows the bird has disappeared from well over half of its breeding range over 20 years; there is little doubt that the range is still contracting (Figure 9).

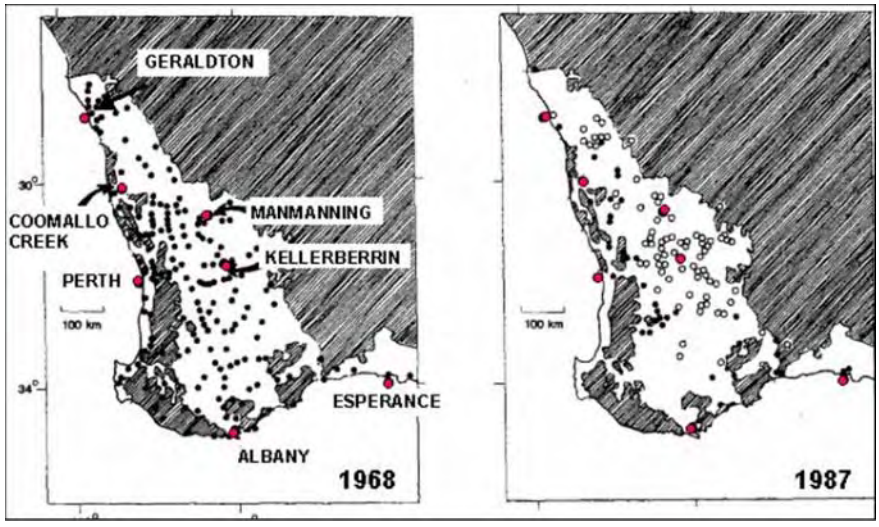

Figure 9: Comparison of the range and distribution of Carnaby's Black-Cockatoo in 1968 and 1987.

In 1998, John Ingram and I published a paper on 28 years of monitoring the population of Carnaby's Cockatoo at Coomallo Creek (Saunders and Ingram 1998). In 1959, 90% of the area was covered with native vegetation. By 1996, the area of native vegetation had been reduced to 25%. As a result of these changes, the breeding population has fallen to a third of its 1970s size and relative breeding success had also fallen (Figure 10).

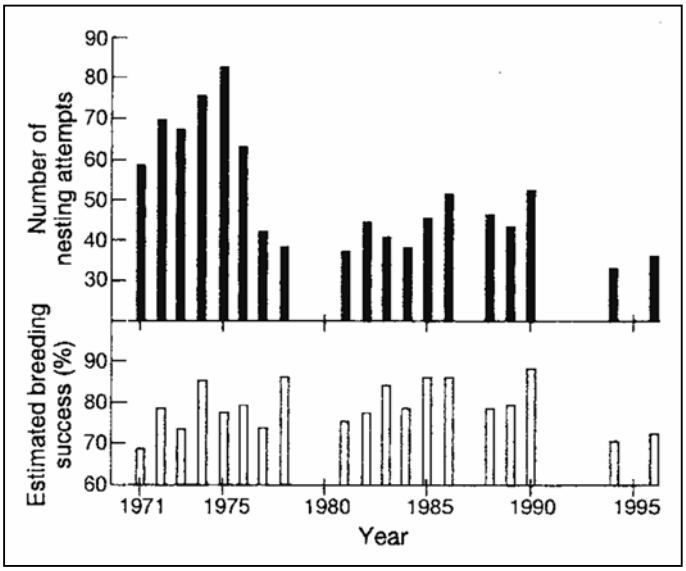

Figure 10: Estimated breeding success and numbers of breeding attempts for Carnaby's Black-Cockatoo, 1971-1995.

Carnaby's Cockatoo, like all the cockatoos in the south-west, nests in large hollows in trees. Many of these are on private land. The trees supplying nest hollows are aging, many are in poor condition, are deteriorating and most are not being replaced (Figure 11).

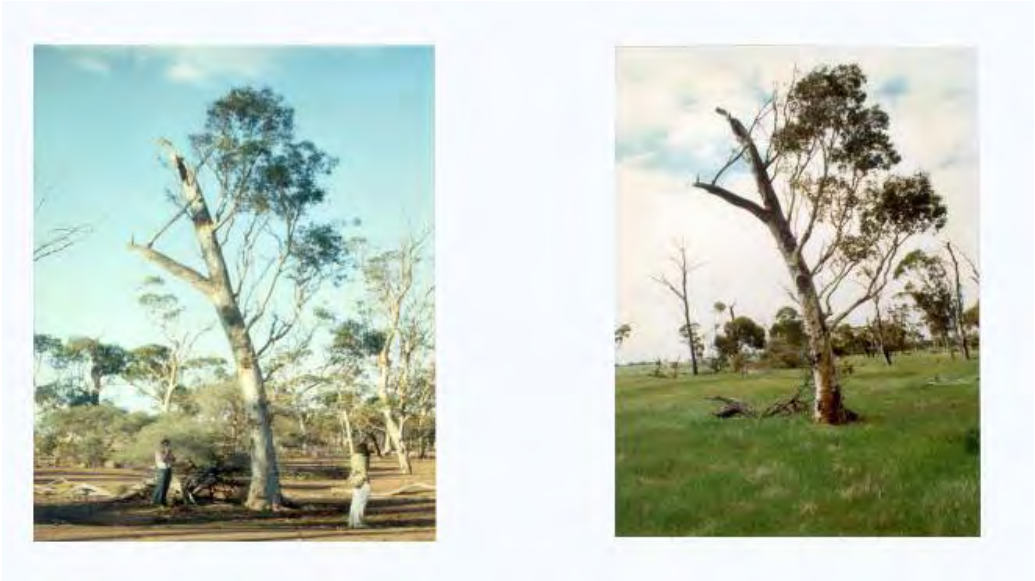

Figure 11: The deterioration of vegetation condition over a 16 year period. Tree T027 in July 1981 (left) and in August 1997 (right). There has been little apparent change in the condition of the tree, however note the thinning of the shrub and tree layers and lack of regeneration of the woodland species.

A study of the condition of trees conducted at Nereeno Hill showed this clearly (Saunders *et al.* 1982). There were few healthy trees in the larger size classes and there has been a dramatic loss of understorey layers. Based on changes in trees with large hollows in them over the period 1978 to 1997, extrapolations indicate that there will be only about 6% of these standing in 100 years. Similar extrapolations made for all salmon gums (other than those with large hollows) indicate that less than 20% of these will be standing in 125 years (Saunders *et al.* 2003). Given that there

apparently has not been any regeneration in this patch since sheep were introduced into it in the late 1920s, the future for these trees is bleak. Observations throughout the wheat-sheep regions of Australia reveal this same pattern of decline, and that it is not being addressed. While there are still many tree hollows in these landscapes, over the next 50 years this will change and nest sites as well as food will be severely limiting for birds like Carnaby's cockatoo that depend on tree hollows for nest sites and native vegetation for food.

In 1968 I started working on a species because it was regarded as a pest and control measures were considered necessary. The results of this research showed that the bird was being controlled, but it was by the changes we have imposed on its landscape. The results of this research have been used to justify listing the species as endangered by the Western Australian Government and the Recovery Plan for the species draws extensively from this research.

Having started my working life on a single species because it was classified as vermin by the Western Australian Government with a bounty on its head in some shires, I ended the study with a conservation issue. The only way that this species can be protected is by the application of the results of landscape ecology and widespread community involvement in extensive landscape reconstruction.

Acknowledgements

I would like to express my gratitude to many people who contributed to this study and on whose properties I worked. I would like to single out: Robert and Gayle Raffan, Peter and Judy Paish, Mary and Basil Smith, Doug and Eleanor Wilson, and John and Kati Wilson on whose properties much of this work was conducted; Stephen Davies who started me on the cockatoo study; and John Ingram for the hard work and diligence he demonstrated throughout this study. Without the assistance of these and many others, none of this work would have been as productive as it was.

Conserving Carnaby's Black-Cockatoo through better Management of Captive Stocks

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Introduction

Almost 30 percent (95 of 330) of the world's parrot species are threatened with extinction. This represents one of the worst conservation records of any major bird family (Snyder *et al.* 2000). The reasons that so many parrot species are threatened are many and varied, but almost all are directly or indirectly attributable to human activities.

In Australia where parrots are generally believed to be both speciose and abundant 15 percent (8 of 53) of the recognized taxa are listed as threatened (Garnett 2000). In Western Australia three species (Carnaby's Black-Cockatoo *Calyptorhynchus latirostris*, Baudin's Black-Cockatoo *Calyptorhynchus baudinii* and the Night Parrot *Pezoporus occidentalis*) and two subspecies (Muir's corella *Cacatua pastinator pastinator* and the Western Ground Parrot *Pezoporus wallicus flaviventris*) are listed as threatened under State wildlife legislation. Four of those taxa are endemic to Western Australia, the exception being the Night Parrot.

Only Carnaby's and Baudin's Cockatoos and Muir's Corella are currently kept in captivity, with Carnaby's Cockatoo by far the most commonly kept. At the end of 2002 a total of only 269 Carnaby's cockatoos were owned and held in captivity by private aviculturists under the provisions of a Regulation 12 (Licence to breed and keep avian fauna) of the *Wildlife Conservation Regulations 1970*. A further 55 cockatoos that were classed as 'derelicts' and that are the property of the Crown (i.e. the Government and people of Western Australia) are held in long-term care by private aviculturists. In addition, there are currently 20 birds held under the provisions of Regulation 28A (Caring for sick and injured fauna). This means that of the total of 344 Carnaby's Cockatoos in captivity (outside of zoos and wildlife parks) in Western Australia, 21.8 percent have a recent wild origin. The number of Carnaby's cockatoo in captivity is partly a function of the ease with which it was collected and trapped from the wild in the early to mid- 20th century and partly due to the extensive research conducted on wild populations (see Saunders 1990; Saunders and Ingram 1998).

Managing captive stocks

There are two elements to the notion of managing captive populations of Carnaby's Black-Cockatoo. The first involves making sure that those birds in captivity actually need to be in captivity. The idea of birds 'needing' to be in captivity relates to wild birds that are sick, injured or orphaned and that cannot be returned to the wild despite best efforts to achieve this. Experience has shown that some birds naturally suffer diseases that result in them developing poor skeletal structure, incomplete flight plumage or metabolic conditions that would normally be fatal in the wild. Cockatoos are also involved in collisions with vehicles and wire fences, or are injured in the nest resulting in them breaking major limb bones or damaging eyes and bills. Some bone injuries can heal properly, but professional veterinary intervention and lengthy periods of rehabilitation by experienced carers are required before the birds are ready for release.

Young birds (<12 months of age) that are separated from their parents lose the opportunity to develop key life skills while in care. These birds, along with older birds undergoing lengthy recuperation from injury, often need to be taught how to recognise natural foods and how to select and manipulate them. Some birds also need to undergo extensive physiotherapy in order to get muscle bulk and aerobic function up to a level comparable to those of wild birds.

In the last five years the Department of Conservation and Land Management (CALM) has worked hard to ensure that those birds that need care get it quickly, that they then receive the best rehabilitation available and that those birds that are fit are released back into the wild. Since 1998, seven birds have been released back into the wild and more will be ready for release in the near future. Despite these advances in the management of wild birds, a small number of birds still cannot be returned to the wild. These birds are now placed with private aviculturists that are licensed to keep black cockatoos and who have prior experience with the genus *Calyptorhynchus*. The birds are endorsed on the aviculturists' licences as 'derelicts' and remain the property of the Crown. The participating aviculturists have the option of pairing the derelict bird with one that they own, or CALM may provide a pair of birds as supply allows. This system has allowed the Department to redress the wasteful situation of single birds or same sex pairs languishing in captivity for no net conservation benefit. The keeping and breeding of these derelict birds is covered by a written and signed agreement (Appendix 1) that confirms that the derelict birds remain the property of the Crown, and that a half share of any progeny bred are to be returned to CALM for disposal, which may include sale by public tender. The proceeds of sales are placed in a trust account and the used to further conservation of threatened species such as Carnaby's Cockatoo.

The system described above covers the birds that need to be in captivity, but an equally important aspect to this equation is the birds that should be in captivity. The birds that should be in captivity are those that are lawfully owned by private individuals (i.e. captive bred or purchased from legal sources), those that are placed with aviculturists by CALM and those that are being cared for under Regulation 28A. Regulation 28A will require members of the public to notify the Department as soon as they come into possession of or commence caring for threatened species such as Carnaby's Cockatoos. This provides CALM with the opportunity to ensure that injured or sick birds receive the best quality care available.

In the 1960s through to the late 1980s a number of aviculturists keeping Carnaby's Black-Cockatoo in Western Australia and probably in many other locations, were claiming captive-breeding successes. If those achievements had been genuine there should have been sufficient young birds entering the trade to meet most or all of the local and Australian demand. However, there was disturbing evidence to indicate that poaching of eggs and chicks from the wild was common and widespread. The poachers showed little respect for the plight of the cockatoos, often damaging the nest trees in their haste to extract the eggs and chicks and rendering those trees useless for any future breeding attempts. Some poachers were more resourceful and created removable doors to allow repeated access to the nest chambers to facilitate annual poaching efforts.

In the late 1980s and early 1990s modern scientific techniques in the form of DNA profiling provided a valuable new weapon in the fight against poachers (see Mell and Wetherall 1992). It became much easier to disprove false claims of captive-breeding and not surprisingly the number of *bona fide* breeders of Carnaby's Cockatoos fell to single digit figures in Western Australia in the years immediately after the introduction of the DNA testing. Since then the number of genuine breeders has increased slowly and the number of incidents of poaching of chicks for the domestic Australian market has diminished and remains at low levels. Poaching of eggs for illegal export to foreign countries remains a problem.

The DNA techniques first developed in the late 1980s required birds to be captured and held securely while a blood sample was collected from the sub-brachial vein that passes over the upper wing bone and close to the skin surface on the underside of the wing. Capturing black cockatoos is stressful for the birds and their owner/carer and also has an element of risk for the people handling the birds. There was also a risk the birds would sustain injuries while being held or that the blood sampling process could damage the large vein that was being targeted. In 2002 the opportunity arose to develop a second-generation DNA procedure and CALM is funding ($5,800) and supporting (provision of DNA material collected from wild birds) a post-graduate student from Murdoch University to perfect a new technique that requires only a single body

feather to obtain sufficient DNA material. The technique should also work with material from eggshells or mummified chicks. Early results indicate that black cockatoos are a little more difficult to deal with in regard to DNA work, but that the technique shows promise. The preliminary results of this work will be presented as the XIX International Congress of Genetics to be held in Melbourne later this year.

To date CALM has not had to test the acceptance of DNA technology in the courts as all alleged offenders have admitted their guilt, attesting to the power of DNA testing in the eyes of the aviculture community. The Department backs up the DNA sampling by applying passive implant transponders (or microchips) into all birds that it releases back into the wild and also to all of the birds that enter the derelict program. This extra piece of security has already allowed us to identify one lost bird and return it to its appropriate aviary.

As part of its monitoring activities of Carnaby's Cockatoo wild populations, CALM has also gathered a sizeable collection of DNA samples (feathers, discarded egg shells etc) from chicks in nests in the wild. Over time this will allow us to build up a dataset that can be cross-referenced against DNA samples from birds of dubious origins. At the same time that the DNA is gathered a graphic information system has been used to plot the location of as many Carnaby's cockatoo nests in the wild as possible. This will allow CALM to not only prove that a DNA sample came from a wild bird but to also work out where that bird originated from. This will bolster legal cases but may also allow us to return chicks to their parents, where they stand a chance of continuing their life as a free bird.

Covering all bases

The conservation of threatened species is most often managed by way of species-specific recovery plans. Carnaby's Black-Cockatoo is no different and a Recovery Plan has been developed and is being implemented by Birds Australia with in-kind assistance from CALM (Cale, 2003). The Recovery Plan is designed to operate for 10 years (2000-2009) and has already received State funding in 2000 and Federal funding for two years 2001-2003.

The establishment of a coordinated management program for the derelict birds and a focus on obtaining high quality veterinary care for sick and injured birds as quickly as possible, along with placement of the birds with skilled aviculturists provides the best opportunities to further reduce the potential for poaching while making use of a previously neglected resource.

The ultimate success of this multi-faceted approach to the conservation of a threatened species will depend on continued commitment by CALM, but it also presents a unique opportunity for community involvement at the group and individual level. In many parts of the world conservation programs involving birds are based solely on activities that provide clear benefits to the species in the wild. Few conservation programs include actions that do no harm to the wild populations, while having other indirect benefits (e.g. to aviculture).

Appendix 1. Copy of the written agreement that is signed by participants in the 'derelict' cooperative breeding program involving black cockatoos such as Carnaby's Cockatoos in Western Australia.

CALM/Perth Zoo Black Cockatoo Cooperative Breeding Program

I wish to take part in the cooperative breeding program for black cockatoos in collaboration with CALM and Perth Zoo. This program involves those held in captivity which are commonly referred to as derelicts and are the property of the Crown and can include pairs where only one bird is a derelict. Participants in the program are subject to the following conditions:

- Birds placed in the program, but held by me, shall remain the property of the Crown as is currently the case with existing derelict birds.
- All birds in the program will have a microchip implanted and blood sampled for DNA analysis. I accept that there is a minimal risk of death of the bird for which neither CALM nor the Perth Zoo is liable. Likewise any losses caused by disease are not the responsibility of CALM/Perth Zoo. (NB: Should any losses be incurred the program will endeavour to replace the bird with a subsequently available derelict.)
- Records of all these birds will be maintained by CALM and also placed on the Australasian Regional Studbook kept by Perth Zoo.
- I may not dispose of any birds that are part of the program without the express written permission of CALM.
- **ALL** progeny produced will have a microchip implant, and blood sample taken by a Vet under the program direction.
- Fifty percent of all progeny produced shall remain the property of the Crown and will be disposed of according to the recommendations of the program. (This will mean they may remain part of the program at the appropriate location.)
- The other fifty percent of progeny shall become my property. I have the right to sell these birds but I am obliged to obtain a transfer authority from CALM and inform the Studbook Keeper of their destination. The program may also offer recommendations of potential buyers through the location of potential partners on the Studbook.

I agree to abide by the above conditions.

Signed: _____ (Print name, address and telephone number)

_____

Date: _____ _____

_____

_____

Clearing of Gnangara Pine Plantation: Implications for Carnaby's Black-Cockatoo on the Swan Coastal Plain

David Mitchell
Department of Conservation and Land Management

Introduction

Pine trees in the Gnangara, Pinjar and Yanchep plantations cover an area of 23 000 ha. Radiata or Monterey Pines *Pinus radiata* were first planted in the area in the1920's, and as early as the 1930's were recognised as an important feeding area for Carnaby's Black-Cockatoo during the non-breeding season. This paper discusses the Gnangara Park Concept Plan and the possible implications for the cockatoo of the planned removal, without replacement, of the Gnangara area pine plantations.

Gnangara Park Concept Plan:

For some time there have been plans to harvest and remove (without replacement) the pines from the area. In 1996 the Government of Western Australia proposed the concept of management of the larger area as Gnangara Park, including removal and replacement of the pines, and management of the area together with surrounding bushland for conservation, recreation and production outcomes.

The proposed Gnangara Park is a very large area. It includes the 23 000 ha of pine plantation together with 70 000 ha of native vegetation, which is primarily Banksia woodland but also includes other vegetation types that may also be important food sources, such as proteaceous shrublands, Jarrah *Eucalyptus marginata* forest and Tuart *E. gomphocephala* woodlands, etc. The Gnangara Park stretches 60 km north-south from Wanneroo almost to Moore River and is 45 km wide (Figure 1).

A multi-agency Technical Working Group was formed in 1998 and prepared a Concept Plan for the Park (Department of Conservation and Land Management, 1999). The Plan was released by the Department of Conservation and Land Management (CALM) in May 1999 and provides a broad statement of intent and direction for future planning and management. It was released as a mechanism to gauge the level of acceptance for the concept and to gather ideas and information to proceed to the next stages of planning.

The Concept Plan has identified four Primary Values of the Gnangara Park. These are Nature Conservation, Resources, Recreation and Interpretation and Heritage. The Plan outlines objectives for each Value, together with principles and strategies to guide overall decision making (Table 1).

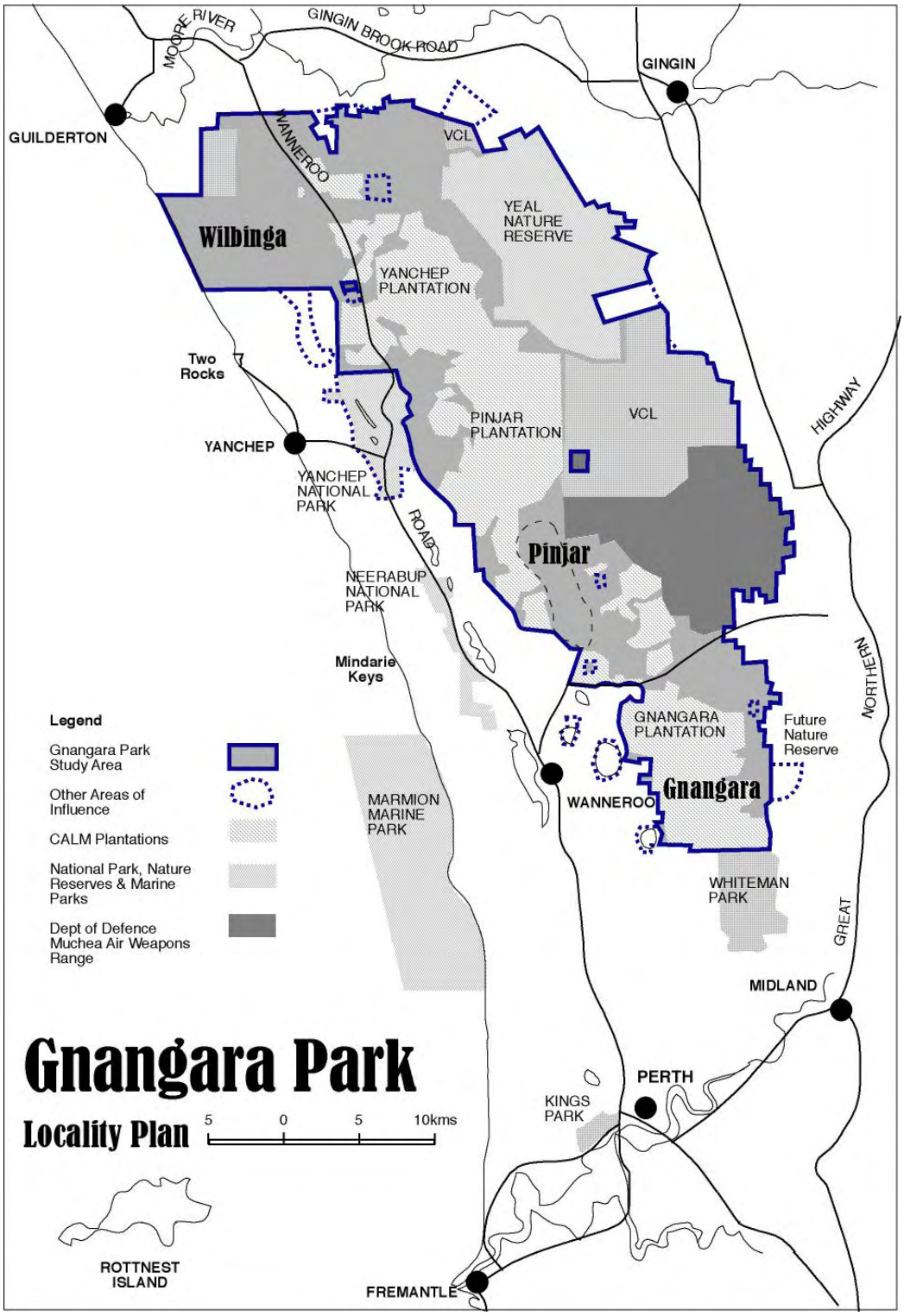

Figure 1: Gnangara Park Locality Plan showing the location of Gnangara Park in the Perth Metropolitan Area.

Table 1. Four Primary Values and objectives identified in the Gnangara Park Concept Plan. After Department of Conservation and Land Management (1999).

Value	Objectives
Nature Conservation	• Protect and enhance existing biodiversity, threatened species, wetlands and vegetation communities • Rehabilitate flora and fauna habitats and remove feral predators
Resources	• Protect and enhance quantity and quality of groundwater and public drinking water supply • Harvest pines within the next 20 years • Extract sand, limestone and other resources
Recreation and Interpretation	• Develop a wide spectrum of recreational opportunities and public access • Interpret primary values to enhance visitor awareness, experience and enjoyment • Provide opportunities for nature-based tourism
Heritage	• Project natural and cultural values • Provide opportunities for appropriate interpretation of natural and cultural heritage values

The Concept Plan deals with the park in a geographical context of six zones, based on broad land uses and vegetation characteristics, and then includes a series of 115 recommendations for each of the 6 zones under the headings of the 4 primary Park values. Three of those zones are primarily pine plantation. CALM will produce a formal Area Management Plan sometime in the future, however in the meantime the Department will also deal with specific issues through existing management arrangements and, where necessary, through production of issue-specific plans and formation of working groups.

Gnangara Park conservation values

The Gnangara Park includes a very large area of native vegetation with significant conservation values. It includes and protects the following:

A large undisturbed area providing a high level of protection to conservation values;

A large arc of native vegetation providing almost a complete west-east transect across the northern Swan Coastal Plain from coast to scarp;

- Most landforms present on this area of the Swan Coastal Plain;
- Native vegetation areas included in previous conservation planning documents –the System 6 report, Forest Management Plan and Bush Forever;
- 30 distinct vegetation types, including wetlands and groundwater-dependent vegetation;
- A diversity of plant and animal species. For example: 750 flora species, including 2 Declared Rare Flora and 18 Priority species, have been recorded in the area;
- Several threatened ecological communities;
- Significant non-breeding feeding habitat for Carnaby's Black-Cockatoo;
- Possibly significant food sources during the breeding season for those Carnaby's Black-Cockatoo now breeding in Yanchep National Park and other areas on the Swan Coastal Plain.

Key management issues include the protection of conservation values from threatening processes such as Dieback *Phytophthora cinnamomi*, feral animals, weeds and frequent fire and managing extractive and exploitative uses such as water, wildflowers, mining and beekeeping.

Management and activities to date

Some additional funding has been received for the Park and, as well as significant inter-agency liaison and negotiation in relation to the sequence of pine harvesting, groundwater supply etc, most on-ground management to date has been in relation to the following issues:

Access control

Management actions consist of track closures, fencing (including 6 km along Gnangara Road), gates and signage. With constant maintenance these measures reduce uncontrolled access – this results in a reduction in rubbish dumping, wildfire and disease spread.

Rubbish clean up

Together with physical barriers and signage, rubbish removal provides the Gnangara Park with a degree of obvious visual management. For example, in May 2001, 500 cars; 1400 tyres and 30-40 semitrailer loads of dumped rubbish were removed.

Fire management

Fire management provides for wildfire minimisation through access control and joint patrols with Police and Local Government, as well as a rapid wildfire response. The Plan also provides for prescribed burning for biodiversity; water (short term increase in recharge); and property protection outcomes. The objective is for a mosaic of different fire ages and regimes, including short rotation in strategic buffer areas to longer rotation and some no planned burn areas.

Revegetation planning and trials

Trials are underway for weed control and revegetation treatments such as spraying, ripping, scarification and fencing. Surveys of natural vegetation regenerating under pines and/or following removal are also underway or planned. Rehabilitation is not included as part of the cost of pine removal, but will follow pine harvest at the Department's cost.

Revegetation after pines

A significant part of the future planning and management of Gnangara Park is concerned with the areas of pine plantation and how to manage them in the context of surrounding and adjoining lands. The question is: what is to be the final state/function of the Park?

The magnitude of the revegetation task (23 000 ha of pines removed over 20 years – i.e. over 1000ha/year) is daunting and can overshadow other management and activities. As a comparison, revegetation following mining usually costs tens of thousands of dollars per hectare. Such a cost applied over the 23 000 ha of pine plantation would be prohibitive. CALM believes it can achieve some form of rehabilitation costing significantly less than this depending on method and quality of result. Even at this rate the total 23 000 ha could cost up to $184 million. Currently even this level of revegetation is not funded. The challenge for the Department is how to achieve some functional revegetation with minimal funding.

Some observations about the area provide guidance to possible solutions and issues. Areas under pines have different characteristics which vary across Gnangara Park. These include soil type and soil moisture (including wetlands), time since pine canopy closure, distance from edge (relates to weed invasion), proximity to remnant vegetation, and fire and silviculture history.

These differences lead to localised variations in the capacity for natural regeneration and different requirements for active revegetation measures. There is a need to map areas to plan different approaches. A number of opportunities are presented and these include the following:

- There are remnants of native vegetation within the plantations. These areas of native vegetation can provide a framework of natural areas within a varyingly rehabilitated plantation;
- A surprising number of understorey species has persisted within the seed bank under the pine plantations. We should aim to make the best use of the natural return of species;
- Areas immediately adjacent to remnant vegetation appear to benefit from seed dispersal from the remnant;
- Some areas such as low lying wet areas naturally revegetate well following pine removal and the additional revegetation required is minimal;
- Some areas of young pines on the Spearwood soils, for example where the canopy hasn't yet closed, have good retention of native understorey species;
- The end point does not necessarily need to be return everywhere of original vegetation. The Gnangara Park concept allows for options to revegetate to produce other outcomes, such as water production and recreation; and
- The time frame is long, which may allow for other options. For example, it may be possible to plant at lower density or in clumps to create a seed source and allow densities to build up over long term.

In addition to these opportunities, however, some problems are presented by the planned removal. These include:

- Some important species do not persist as soil-stored seed under pines and so do not naturally return following pine removal. Most significantly for cockatoo conservation, Banksias are in this group. Therefore there is a need to direct seed and plant Banksias and some other species;
- Other areas, mostly to the south and around Gnangara, have been under pines for a long period of time and so have a long history of shading and prescribed burning. In these areas few native species re-emerge after pine removal and require greater input for successful revegetation. However the dense pines have also suppressed weed invasion and may thus provide a weed-free window of opportunity for rehabilitation;
- Bare, unrehabilitated areas are prone to weed invasion, which will make future rehabilitation efforts more difficult.

Pine replacement – the process:

In Gnangara Park the most efficient method of rehabilitation of the plantation areas is not the only factor that will influence the rehabilitation methods chosen. There is a need to balance several requirements, which include maximising economic return from the harvest of pines (this influences the timing and sequence of harvest), and reducing the water interception and use by pines or replacement vegetation to maximise groundwater recharge. A return to the original vegetation over the whole area is neither the aim, nor indeed possible.

The proposed strategy for revegetation following pine removal is to establish good quality native vegetation around key conservation assets such as rare species, wetlands and significant remnants, and to establish good native vegetation corridors and linkages between remnants. The remaining areas will receive less intensive and cost effective revegetation so that the result is a self sustaining system that supports a range of wildlife and acts as a buffer to the core conservation areas.

In some other areas that are identified as important to groundwater recharge, low-density vegetation (natural regeneration with minimal supplementation) would be managed to maximise recharge, while retaining some ecological function.

Management will include the timing and sequence of pine removal to create buffers and stimulate regeneration in link areas. However it may not be possible to optimise this sequence for native vegetation revegetation due to the additional requirements for pine harvest and water production.

The Department has established a technical working group to advise on revegetation methods, and some trials on areas where pines have been removed have commenced.

Pines as food – implications for Carnaby's Black-Cockatoo

The main value of the pines to Carnaby's Black-Cockatoo is as a food source, and to a lesser degree as roost sites. For Carnaby's Black-Cockatoo, it is probable that the proposed rehabilitation is unlikely to replace a food supply on a kJ per hectare basis, of Banksia and other native species equal to that supplied by the pines, at least not in the short term.

The first question arising from this is to determine if such an outcome is significant for the Carnaby's Black-Cockatoo, especially given that there is up to 70 000 ha of alternative food source. If the loss of pines does pose a significant threat to the cockatoo, the next step is to determine the specific mechanism of the threat and to modify the harvesting and rehabilitation program at Gnangara to mitigate against the threat. This may include influencing where pines are removed and the rehabilitation requirements.

In short we do not know if the pine removal will be significant to Carnaby's Black-Cockatoo, although it is hard to imagine such a large change in land use will not be important. Thus, in the remainder of this discussion I will pose questions aimed at clarifying the consequences of removal of the pines as a food source for the cockatoo on the Swan Coastal Plain.

Relevant research

Cooper *et al.* (2002) looked at the energy content of assorted seeds that form significant proportions of the diets of several species of cockatoos, including Carnaby's Black-Cockatoo. This list of food seeds included Radiata Pine *Pinus radiata* and Candle Banksia *Banksia attenuata* and so can provide information relevant to the major food items in Gnangara Park for Carnaby's Black-Cockatoo.

The study measured the energy content of seeds of these species and calculated the total energy content of a fruit. While the total energy content of a Banksia cone (63.9 kJ nut^{-1}) was almost double that for a pine cone (39.4 kJ nut^{-1}), both were significantly higher per nut than the next highest food source, Marri (*Corymbia calophylla*) (7.32 kJ nut^{-1}), with all other food types tested having less than 2 kJ nut^{-1}.

The energy content of these food items was then related to the daily energy requirement of cockatoos to calculate the number of nut/cone/seed cases required by each bird every day (Table 2). Given that both Banksia and Pine cones have a number of large seeds, it is not surprising that both can provide a significant amount of energy from a small number of fruit.

Table 2. Number of individual fruit (cones, nuts or seed cases) required to meet the daily field energy requirement of a Carnaby's Black-Cockatoo. After Cooper *et al.* (2002).

Food source	Number of fruit (cones, nuts or seed cases) required
Banksia attenuata	11
Pinus radiata	18
Corymbia calophylla	99
Eucalyptus marginata	585
Allocasuarina fraseriana	637
Hakea sp.	1962
Persoonia longifolia	2792

An optimal diet is a function of maximising the energy input from the food while minimising energy and time expended in locating and then extracting seed from the fruit. So an energy-rich fruit may still not be optimal if it takes too long to locate fruit and then extract seed.

A further study by Cooper (2000) looked at food manipulation by cockatoos, including Carnaby's Black-Cockatoo. While indicating that there are differences between food handling effort (and how to go about such a study), this paper did not include Radiata Pine or Banksia and so does not provide the information needed here. With current information it is thus not possible to determine if it is more energetically efficient for a Carnaby's Black-Cockatoo to find and extract seed from 18 pine cones, or find and extract seed from 11 Banksia cones, or find and extract seed from 99 Marri nuts. However as Carnaby's Cockatoos eat a lot of pine cones, it must be a worthwhile food source.

It is likely that there would be seasonal variations in food type availability, so birds may be forced to feed on a food item of relatively poor energy to effort return if there were no alternatives. Similarly production of seed may vary from year to year based on climatic (for example, rainfall) or management (for example, fire) impacts. Cooper et al. (2002) also note that "specific nutrients, vitamin and mineral contents of various foods may also be important and may explain why, at certain times of the year, birds feed on items such as *A. fraseriana* and *P. longifolia* seeds that clearly are not optimal in terms of energy gain and time costs."

What additional information is needed?

It is obvious that Carnaby's Black-Cockatoos eat pine seed from Gnangara Park and so the 23 000 ha of pines form an important non-breeding feeding habitat on the Swan Coastal Plain. However there is also 70 000 ha of native vegetation within Gnangara Park (47 000 ha within the CALM estate, and 23 000 ha in other lands), which is primarily Banksia woodland but also includes other vegetation types (proteaceous shrublands, Jarrah forest and Tuart woodland etc) all of which may be important food sources. Given that this 70 000 ha of native vegetation will be retained, is removal of 23 000 ha of pine significant for the Carnaby's Black-Cockatoo? Can this native vegetation, along with the proposed revegetation on the pine areas, provide sufficient food for the Carnaby's Black-Cockatoos? Is food limiting for the cockatoo on the Swan Coastal Plain?

It is possible that pine cones are taken in preference to adjacent native food. Perhaps taking pines is a very easy food (high energy to effort – a "fast food hit") and so removal of pines will simply require the Carnaby's Black-Cockatoo eat native food, albeit with an increase in the feeding effort each day.

To determine if the removal of pines is significant we need to answer several questions. These relate to how well the two vegetation types provide food for Carnaby's Black-Cockatoo, and how the birds actually use the two vegetation types. We also need to consider which birds from within the total population of Carnaby's Black-Cockatoo are using Gnangara Park and how pine removal might affect them and therefore the species recovery.

Annual production of both vegetation types

We know from Cooper et al. (2002) the energy content of pine and Banksia fruit. With some additional information about tree density and cones produced by each tree, it should be possible to roughly calculate the food production in the two main food areas as kJ/ha/year. This could then be used to determine the relative value of the two vegetation types – as total food availability throughout the Gnangara Park and therefore number of birds that can be supported, or alternatively as ha/year of each vegetation type required by a Carnaby's Black-Cockatoo. With additional research (noted below) it would also be possible to include a correction for foraging and feeding effort.

Using estimates of the total population of Carnaby's Black-Cockatoo on the Swan Coastal Plain it should be possible to determine if there is sufficient food in the native vegetation areas in order to determine if food is limiting at all.

Some of this information may be already available through existing studies. For example, research of regeneration of Banksias may provide information on the annual production of Banksia cones and seed. Similarly pine silvicultural research may provide information on pine cone production.

It is important to remember that there are likely to be spatial and seasonal patterns of production. Factors that are likely to influence production of seed include climatic (e.g., rainfall), site (e.g., soil type or moisture), or management (e.g., fire) impacts. Where pines are stripped of all fruit there might be a need for one or more years for the pines to "recover" from a feeding episode.

It should also be remembered that native vegetation offers other food types for the cockatoos, including seed from different plant species, and invertebrates such as borers and grubs.

Foraging and extraction effort.

We have some information on how much energy each food source provides. Continuation of food manipulation studies such as those by Cooper (2000) to include pine and Banksia will provide a correction for foraging and feeding effort and so provide better determination of the relative value of the two food types.

Spatial and seasonal patterns of use.

While simple calculations of food availability on a kJ/ha basis is valuable, it needs to be supplemented by field observations of how Carnaby's Black-Cockatoos actually use pines and Banksia. That is, how do the birds apportion their feeding effort between the 2 food types? For example, do birds alternate between pines and native feed during the day or do they eat only pine seed until it is gone etc. Given a choice, are pines preferred by Carnaby's Black-Cockatoos over adjacent native food? Factors that influence patterns of use may include including distance from roost sites, and learned behaviour. Some of these field observations may already have been made, but not reported or published, or additional studies may be required to clarify patterns of use. It is also important to investigate what other areas the birds use. How significant are other native vegetation areas in the Perth area? To what degree are birds from Gnangara Park moving around the Perth area, feeding from other native and introduced food plants?

Which birds use the Gnangara Park area?

We do not seem to have clear information on the number of Carnaby's Black-Cockatoos that use the Gnangara Park. Flocks of over 9000 birds have been reported in the pine plantations in recent years. What is the make up of these flocks, how many are breeding pairs, non-breeding

adults or juvenile birds? Where have these birds come from, both in terms of the breeding areas as well as during the non-breeding season? There have been some suggestions that the Perth population of cockatoos is contracting into Gnangara.

Additional questions arise in relation to breeding birds. Is the Swan Coastal Plain providing resources for high priority breeding populations? Can we link these birds to one or more of the priority breeding sites? What is the breeding catchment area? Are we looking at the total population of Carnaby's Black-Cockatoos derived from the northern wheatbelt, or a smaller population from within a part of the breeding range?

Is the pine food source at Gnangara important for the breeding success of birds? Are they putting on fat reserves to allow them to breed and might the removal of the pines subsequently reduce breeding success when they return to the breeding area? Or is breeding success only related to feeding habitat in the actual breeding area, and the importance of the coastal plain food sources restricted to requirements for survival over the non-breeding season? Lastly, we may ask how important is this Gnangara food source for the survival of juvenile birds? Is the area important for the pairing of birds and future entry into the breeding pool?

Is pine removal at Gnangara a significant threat to Carnaby's Black-Cockatoo?

As yet we don't have a good idea of what the impact of removal of the pine food source at Gnangara will be on Carnaby's Black-Cockatoo. It is possible to imagine the impact as being minimal or huge. Without knowing we cannot factor it into the planning process for Gnangara Park. Additional information, as described above, will allow a rough indication of the magnitude of impact, and more detailed investigations will allow clarification of the mechanism of impact.

Finally, we should consider the relative significance of this threat to the species recovery compared with other threatening processes. In particular we need to consider those threats operating at the time of breeding, such as nest hollow availability (including protection and production), food availability during breeding (protection and creation of feeding habitat in breeding areas) and nest robbing.

If the loss of pines is found to pose a significant threat to the Carnaby's Black-Cockatoo, it is important to identify the mechanism of impact and then factor that into Gnangara Park management and pine harvesting planning as soon as possible, including influencing where, and when pines are removed and the rehabilitation requirements.

White-tailed Black-Cockatoos: Identification Challenges and Changes in Distribution and Status, and links with a Community Program - Cockatoo Care

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Introduction

In 2000 the south-west corner of Western Australia was named one of the world's 25 biodiversity hotspots, an area where exceptional concentrations of endemic species are undergoing exceptional loss of habitat (Myers *et al*., 2000). Four of these endemics, 3 black cockatoos and one corella, are still losing habitat and are threatened or endangered and in need of special protection.

Carnaby's and Baudin's Black-Cockatoos were only recognised as separate species in 1979. This arose because of the great similarity between the two species: they are often extremely difficult to identify, even for experienced observers. Bill size and shape and their calls are the most reliable means of identification. Because of this all of the early observational records and many recent ones where misidentification has occurred have resulted in a high degree of ambiguity or error in recording the two species. The distribution and status of both species is currently being studied. Judging from preliminary surveys in the south-west Carnaby's greatly outnumber Baudin's in order of 5:1, and the conservation status of Baudin's Cockatoo is in need of urgent review.[1] Carnaby's Cockatoo is now known to breed in the northern Darling Range, in the deep south-west and on parts of the Swan Coastal Plain. A reference collection of food taken by both species is being compiled.

The Western Australian Museum work on Carnaby's Cockatoo has been largely peripheral to the main study on the breeding biology of the Forest Red-tailed Black-Cockatoo *Calyptorhynchus banksii naso*, Baudin's Cockatoo *C. baudinii* and Muir's Corella *Cacatua pastinator pastinator*. This is a long-term project to document the current distribution, status, relative abundance, habitat preferences, breeding, diet and movements for these taxa in the south-west. This paper discusses some differences in the distribution and food of the two white-tailed black cockatoos and reports on the ways in which the 'Cockatoo Care' program supports the Museum's work on cockatoos in the south west of Western Australia.

Identification and distribution

It is often extremely difficult to differentiate between the two species of white-tailed black cockatoo, especially in southern forests where both species regularly occur and sometimes feed close together. Bill size and shape and their slightly different calls are the only reliable means of identification. Location and habitat can be very misleading. For example, while it would be reasonable for you to assume that if you were in the northern or eastern wheatbelt or on most of the Swan Coastal Plain north of Mandurah, the white-tail you are looking at is a Carnaby's Cockatoo, it is likely that you would be almost 100% correct. However, if today you were in southern forests throughout the south-west corner e.g. at Jarrahdale, Collie, Bridgetown,

[1] Since the Symposium in July 2003, recognition of the change of status of two of the forest cockatoos, Baudin's Black-Cockatoo *Calyptorhynchus baudinii* and the Forest Red-tailed Black-Cockatoo *C. banksii naso*, has resulted in nominations for the listing of Baudin's Cockatoo as Endangered and Forest Red-tailed Black-Cockatoo as Vulnerable. A Recovery Plan for the Forest Cockatoos has been written and a Forest Cockatoos Recovery Team now oversees a recovery program for these two species and Muir's Corella *Cacatua pastinator pastinator* – *Ed*.

Nannup, Lake Muir, Denmark or Albany or on the southern Swan Coastal Plain (Bunbury to Busselton) and you assumed that the white-tail black cockatoo you are looking at was a Baudin's Cockatoo, then you would, in around 80% of cases, be wrong. Judging from our recent preliminary field work throughout the south-west corner, the relative abundance of Carnaby's Black-Cockatoo is much greater than that of Baudin's with the former outnumbering the latter by at least 5:1.

Carnaby's Black-Cockatoo is distributed in the south-western portion of WA; north to the lower Murchison and east to Nabawa, Wilroy, Waddi Forest, Nugadong, Manmanning, Durokoppin, Noongar, Lake Cronin, Ravensthorpe Range, the head of the Oldfield River, 20 km ESE of Condingup and Cape Arid. It is also casual on Rottnest I.

The distribution of Baudin's Black-Cockatoo covers the south-western humid and subhumid zones north to Gidgegannup and Hoddy Well (between Clackline and Toodyay), east to Wundowie, the lower Darkin River, Wandering, Quindanning, Kojonup, and King River, and west to the eastern strip of the Swan Coastal Plain including West Midland, Byford, North Dandalup, Yarloop, Lake Clifton, Yalgorup, Wokalup, Bunbury, Capel and Busselton . It is also recorded between Cape Naturaliste and Cape Leeuwin, in the Stirling and Porongurup Ranges, and east along the south coast to Waychinicup National Park.

Status

Carnaby's Black-Cockatoo is a postnuptial nomad, tending to move west after breeding in parts of the wheatbelt (Johnstone & Storr, 1998). It is uncommon to common in the subhumid zone and wetter parts of the semiarid zone, and scarce and patchily distributed in the driest parts of range (e.g. north of Arrowsmith Lake and east of Marchagee, New Norcia, Toodyay, Tarin Rock and Lake Magenta). Judging from recent surveys the species appears to be increasing in relative abundance in the northern jarrah forest (e.g. Jarrahdale and Collie) and in the deep south-west (south of Margaret River, Nannup, Bridgetown and west of Albany). It is relatively common in the far south-east of its range (Albany to Esperance). The birds are usually recorded in pairs or small flocks, but are also seen in large flocks of up to 7000 in the non-breeding season (late spring to mid-winter), especially on the Swan Coastal Plain. For example in mid-2003, the WA Museum recorded flocks of over 7,000 in *Dryandra* scrub near Burns Beach; about 1,000 at Nilgen Reserve, flocks up to 1,400 near Mandurah, flocks up to 750 at Nannup and up to 200 at Denmark and Albany.

Baudin's Black-Cockatoo is also a postnuptial nomad. Between March and September its movements include visits to the central and northern Darling Range and adjacent far eastern areas of the Swan Coastal Plain. Across its range, the species is scarce to moderately common, being most numerous in September to December in the deep south-west during the Spring breeding season and in the northern Darling Range during autumn to winter (April-August). The cockatoos are usually in recorded in small flocks of up to 27 but are occasionally recorded in larger flocks of up to 50 or aggregations of up to 1,200 at drinking sites or roosts.

Breeding

Carnaby's Black-Cockatoo breeds mainly in the wheatbelt but it would appear that with land clearing the centre of this cockatoo's range has shifted considerably southwards and westwards since the middle of the last century. In recent times we have recorded breeding in the northern Darling Range at Bindoon, Chittering, Walyunga, The Lakes, the Upper Helena River , near Christmas Tree Well, Karragullen, Serpentine National Park and Bannister. It has also been recorded breeding on the Swan Coastal Plain at Yanchep, east of Gingin, Mooliabeenee, south of Mandurah and near Bunbury and in the deep south-west at Nannup. There are also unconfirmed reports from Baldivis and Northcliffe, and birds have been observed prospecting hollows in Tuarts *Eucalyptus gomphocephala* at Shenton Park in the Perth Metropolitan Area.

Baudin's Black-Cockatoo breeds in the south-west Jarrah-Marri *Eucalyptus marginata-Corymbia calophylla* and Karri *E. diversicolor* forests and Wandoo *E. wandoo* woodland north to Serpentine and possibly also further north, with unconfirmed reports from near Christmas Tree Well and Hovea. It occurs east to Kojonup, Albany and possibly further east to about the Waychinicup National Park and there are also unconfirmed reports from near Bunbury.

Within the study area, our objectives in relation to breeding for both of these species are as follows:

1. Document and monitor nests with details of nest trees including hollow size, height and aspect of hollow, circumference of nest tree at breast height, distance apart of nests and details of local vegetation. These details will provide a profile of a preferred nest site. Nest tree characteristics may also help provide a protocol for identifying primary habitat trees (trees of 80-90 cm diameter) that may be potential nest trees.
2. Document clutch size, incubation period, fledging period, breeding behaviour and movements.
3. Locate nests during the breeding season in Spring to early Summer and also Winter for Baudin's Cockatoo. Trees with nests are marked, measured, photographed and map coordinates plotted using a Global Positioning System (GPS). Nest trees are also scored using the K. Whitford senescence scale and hollow characteristics, including entrance size, depth and floor space, are recorded.

Food

Carnaby's Black-Cockatoo has been observed feeding on a wide range of foods including the seeds of *Banksia, Dryandra, Hakea, Eucalyptus, Corymbia*, *Grevillea*, *Mesomelaena*, *Pinus* and *Allocasuarinna* spp. It also feeds on the flowers of *Dryandra sessilis, D. lindleyana, D. quercifolia, D. squarrosa, Lambertia inermis, Banksia grandis, Eucalyptus* spp., *Corymbia, Grevillea* and *Calistemon* spp. and also on fruiting nut trees, fruiting apples, soft fruits (e.g. persimmons), Plane trees, Liquidambar, and the seeds of Corkscrew (also known as Storksbill or Wild Geranium) *Erodium spp.* and Wild Radish *Raphanus raphanistrum*. The birds also extract insect larvae from both live and dead trees.

Baudin's Black-Cockatoo also takes a wide variety of foods and has been recorded feeding on the seeds of Marri *Corymbia calophylla, Eucalyptus* spp*., Banksia grandis, B. littoralis, B. ilicifolia, Hakea undulata, H. prostrata, H. trifurcata* and *Xanthorrhoea.* The birds also feed on the flowers of *Banksia* and *Eucalyptus* spp*.,* the seeds of introduced trees *Macadamia* and *Pinus*, fruiting apples, pears and persimmons and the seeds of weeds such as Corkscrew *Erodium* spp. They have been recorded taking insect larvae from live or dead trees.

Although there is considerable overlap in the foods of both species, their timing is often very different. For example, in mid-2003 in northern forests we have noted Carnaby's feeding a great deal on the seeds of Jarrah *Eucalyptus marginata* whereas in the same area Baudin's Cockatoos were feeding mostly on Marri *Corymbia calophylla.*

A reference collection (including photographs) of the food of both species (also other parrots) is being compiled by R.E. Johnstone and T. Kirkby . This, along with our recent findings on distribution, relative abundance and breeding etc., will be available on the 'Cockatoo Care' website.

Cockatoo Care

The Cockatoo Care Program is a joint initiative between the Water Corporation and the Western Australian Museum. It focuses on protecting three species of Black Cockatoo endemic to the Southwest of Western Australia: Baudin's, Carnaby's and the Forest Red-tailed Black-Cockatoo.

The Cockatoo Care project has four main components:

- Supporting the WA Museum's research into the distribution and ecology of each species and threats to their survival. Observation cards have been developed to enable the public and the Water Corporation's Rangers to document sightings of black cockatoos. This is crucial information for conservation and sustainable forest use.
- Habitat enhancement, via nest box installation and habitat planting, to encourage the proliferation of each species. Extra large, specially-designed nest boxes are being installed throughout areas where the black cockatoos are found, the first trialled for Baudin's and the Forest Red-tailed Black-Cockatoos and Muir's Corella. A rehabilitation program is being developed to plant cockatoo food and habitat species and encourage involvement for community members who have expressed an interest in helping the cockatoos.
- Assessment of the impact of feral honeybees due to concerns that feral bees are competing with black cockatoos for nest hollows and food. A research project is currently being planned to determine the impact of feral honeybees on black cockatoo populations and to develop effective feral bee eradication methods.
- Community education and involvement to raise community awareness and concern. Educating the community about the importance of black cockatoo conservation is a critical role of the Cockatoo Care project. The main avenue for promoting the cockatoo conservation message is via the Cockatoo Care website, signage and promotional displays.

Since the launch on Threatened Species Day, 7 September 2001, there has been an overwhelming response to help the survival of cockatoos in Western Australia. Visits to the Cockatoo Care Website now average 1,600 per day, with over 243,000 visits between January and November 2002 and over 394,000 Cockatoo observation cards submitted. Forums, workshops, school programs and the art treasures 'Cockatoos by Conolan' have all risen from Cockatoo Care and helped gain valuable data and community support. This program is also linked with the Western Australian Tourism Commission's Bibbulmun Track initiative 'On the Trail of the Red-Tail'. Many hundreds of observation cards, letters and phone reports have been received through the Program and through Museum volunteers and researchers. These are being databased and provide information on distribution, flock size, habitat preferences and movements of cockatoos throughout the south-west but especially in southern water catchments.

Some Practical Steps for enhancing the Status of Carnaby's Black-Cockatoo

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Introduction

In 2001 the Moore Catchment Group was awarded a community conservation grant from the Western Australia Minister for the Environment to examine the value of volunteer efforts at rehabilitation work aimed at improving the conservation status of Carnaby's Black-Cockatoo. The project began on May 9, 2001. In the course of the succeeding nine months it was possible to discuss the project with members of the Moore Catchment Group, agency personnel research workers and many landholders from the catchment area.

Results of the project

The role of volunteers

The part played by volunteers in planting vegetation that will benefit Carnaby's Cockatoo, either directly or indirectly, was a particular focus of this project. Volunteer effort has been directed at:

- Collecting seed for germination
- Growing seedlings for subsequent planting
- Planting seedlings on organised planting days

At least 34 voluntary groups were taking part in this endeavour, including many landcare groups and schools, both public and private. In order to get first hand experience of the organisation of planting days, two were observed in the course of the project, one by Danika Loomes and the other by Brenden Metcalf. The plantings were well organised and competently executed.

At Coorow, a Mingenew-based nursery delivered the seedlings to the Landcare office , where they were collected by farmers, often by one for several others. At one site, Danika observed 5 planters from Edith Cowan University at work, only some of whom had done planting on previous occasions. Two people used a mechanical planter, three used hand planters and one used a shovel, in soil that had been previously ploughed with furrows 1.5-2 m apart. The site was exposed, high in the landscape, on a granitic plain. Planting did not start until about 3 pm but was well organised once it got going. Seedlings were planted 2-3 metres apart. An earlier planting there had failed because the seedlings were eaten by rabbits and kangaroos. Rabbit baiting had been stepped up since then, but, because they were expensive, insufficient tree guards were available to protect the seedlings in the current planting. The seedlings will need protection from wind as well as herbivores.

At least ten plant species were planted, including *Eucalyptus hypochlamydea*, *E. loxophleba, Melaleuca cordata, M. thyoides, M. uncinata*, *M. viminea*, *Allocasuarina campestris, Casuarina obesa, Calothamnus gilesii* and *C. quadrifidus*. Of the plants used, *E. loxophleba* can provide nest sites, and the *Banksias* and *Casuarina obesa* can provide food for Carnaby's Black-Cockatoo. The other species were suitable for the soils in which the plantings were made. The purpose of these observations was to record the behaviour of typical volunteer groups and their methods of plantings. It was not considered relevant whether or not the species planted would help the cockatoos directly.

At Guilderton the planting was at three different sites on the flood plain of the Moore River. Sixty two different people attended, although they were not all there at one time. Some were

from Kingsway Christian College but there were many parents, locals and farmers as well. Most of the planting was by adults, two or three of whom organised where the plantings were to go. The people planting used a hand planter, without fertiliser, although the pots had Osmocote, a slow-release fertiliser, in them. Most eucalypts were planted 4-5m apart, but other species were planted closer together, and planting continued until the area was filled. About 6000 seedlings of ten species were used, including Tuart *Eucalyptus gomphocephala* , Flooded Gum *E. rudis*, *Melaleuca* spp., two *Banksia* species and sedges. The whole area planted, partly rocky and partly floodplain, was about 4-5 ha.

Planting techniques

Visits to sites where plantings had been made, especially at Guilderton and Marchagee, and discussion with farmers, indicated that previous plantings were usually 70-90% successful, unless some factor intervened, such as sheep getting through a fence, that destroyed the whole planting. Observations made during this project suggest that these figures are probably unduly optimistic. Discussion with Dr. Colin Yates, who has studied the natural regeneration of Salmon Gum, determined that this species, and probably other wheatbelt gums, grew fastest and survived best if there was no serious competition from other plants around the planting. It therefore seemed sensible, in terms of maximising results, to plant at the distance apart exhibited by trees in mature stands. Measures were made of the inter-tree distance of Salmon Gum ***Eucalyptus salmonophloia***, York Gum ***E. loxophleba***, Gimlet ***E. salubris***, Wandoo ***E. wandoo*** and Acorn Banksia ***Banksia prionotes***. The results are shown in the table below:

Table 1: Spacing, in metres, of mature stands of five species of wheatbelt trees. Key: n = number, s.d. = standard deviation.

Tree species	n	mean	s.d.
Salmon Gum	92	15.76	7.47
Gimlet	120	9.22	4.73
York Gum	121	12.37	6.38
Wandoo	120	10.66	6.47
Acorn Banksia	120	7.39	4.48

Bearing in mind that the trees will grow fastest where competition is least, and that for the eucalypts, the aim is to create stands of mature trees in which hollows will form for nesting, it would be sensible to plant the seedlings at wider spacings than is done at present. The principle would be to use as a guide the mean distance apart of mature trees, plus one standard deviation. This would suggest, rounding to a convenient figure, that Salmon and York Gums should be planted 20 metres apart, Wandoo and Gimlet 15 metres apart and Acorn Banksia 10 metres apart.

Relation between breeding areas and food sites

Banksias planted to provide winter food for Carnaby's Cockatoos have begun to flower within four years of planting, although such small plants have few flowers. The biology of the bird is such that once the female starts to incubate, she is fed by the male until the chick is two to three weeks old. To facilitate the male's efforts the plantings of food plants, such as ***Hakea, Banksia, Dryandra*** and ***Grevillea*** species, should be located within practical flying distance from the nest site. At Manmanning, Denis Saunders researched the distance males were prepared to fly to collect food for the female, and this was found to be 2.5 ±0.2km (range 0.6-12.1km) (Saunders, 1980), but there was no such information available for the Moore Catchment. This information would give an indication of how close plantings of food species should be to known nest sites, and help to make these plantings as effective as possible for the birds.

The size of planted areas in relation to cockatoo food requirements

Christine Cooper (Cooper *et al.,* 2002) has been able to determine the basal metabolism requirements of Carnaby's Black-Cockatoo. She has converted this into the number of seeds or fruits of particular species that are needed to maintain an individual bird each day. Thus a Carnaby's Cockatoo requires 637 Sheoak cones, or 100 Marri *Corymbia calophylla* seeds, or 1961 Hakea seeds, or 12 Banksia cones to service its basal metabolism. Obviously these are minimum figures. The energy required by a bird can be divided into a) basal metabolism – the energy required to run its bodily functions, b) maintenance energy – the energy required to move and feed, and c) reproductive and moulting energy. In relation to Cooper's figures, the bird will require about half as much again to service its maintenance behaviour. But these figures give the possibility, if the amount of fruit carried by individual plants is measured, of calculating how many plants should be growing in a woodlot to feed a cockatoo for the months of the breeding season, and therefore the number that need to be planted to feed a local population. Such a calculation would not be very precise, but could undoubtedly provide an order of magnitude, for example 10, 100, 1000, for which to aim when designing a planting of food plants.

Some progress has been made along this line of thought. Through the help of the non-profit organisation Men of the Trees Christine Cooper (pers. comm.) has been able to compare the energy content of the seeds of several additional native species. The results are shown in Table 2.

Table 2: Energy contents of the seeds of some native plants.

Plant species	Energy content (kJ/gram)
Allocasuarina campestris	25.63
Allocasuarina huegeliana	23.93
Dryandra sessilis	22.96
Grevillea paniculata	28.62
Hakea incrassata	23.21
Hakea preissii	25.12

These figures show that the seeds of these six species each contain much the same amount of energy per gram, although some seeds will be larger than others. But the seeds of the two *Allocasuarina spp.* will be of the same order of magnitude as the Sheoak seeds used in Cooper's initial work (Table 3) and the seeds of the four Proteaceae will be of the same order of magnitude as the *Hakea* seeds she used, so that her figures of the number required to support basal metabolism of the birds can reasonably be generalised to related plants. These figures will eventually provide some guide as to how many plants need to be present in a planting to support a given number of cockatoos, once we know the average number of fruits produced by each species. The acquisition of this information should be a priority for future research.

Table 3: Energy content of the seeds of three plant species (after Cooper *et al* 2002).

Plant species	Energy content (kJ/gram)
Allocasuarina fraseriana	21.7
Banksia attenuata	22.0
Hakea sp.	21.1

The effectiveness of school children and the success of plantings

Volunteers plant very large numbers of plants. For example in the Coorow Bushcare District something like 63,000 seedlings were ordered for 2001. Of eight properties for which Glenn Yeatmann had figures, the average number of seedlings per property was 3,200. Thirty one plant species were represented, including ten tree species and 21 understorey species. Flooded Gum, Salmon Gum, York Gum were included, all known nesting trees, but no *Hakea, Banksia, Dryandra* and *Grevillea* species were in the list, all important food plants. In 2001 18 volunteers from Edith Cowan University helped in the plantings and the success of the 2000 plantings was reported to range from 10 to 90 percent survival.

Detailed notes have been kept by Alison Doley on the plantings by school children at two farms in the Coorow district. In the 1996 planting at one farm, the *Casuarina obesa* planted on the west side all died, some of the *Acacia acuminata* planted to the north survived, but none of the *Banksia prionotes* planted on the south east corner of a second property remain. North Beach Primary School raised 600-800 plants each year for these and subsequent plantings.

In 1997 and subsequent years, plantings were on a sand blowout on another local property. *Casuarina obesa* and *Banksia prionotes* were planted in 1997. The *Casuarinas* were eaten back by rabbits and kangaroos but the *Banksias* did better, especially those protected by old tyres. The children came from North Beach and Coorow Primary Schools. Farmers joined them, sprayed the weeds and worked the ground before planting, as well as providing the old tyres to protect the seedlings from farms from the Coorow rubbish dump and Winchester Cemetery and supporting the project in other ways.

In 1998 both schools again participated and planted the same two species plus *Banksia attenuata*. Again in the wet year of 1999 the two schools participated, planting both *Banksias*, but no *Casuarina*. In 2000 only North Beach Primary School children came, planting 740 seedlings of *Casuarina obesa, Banksia prionotes, B. attenuata, Acacia acuminata* and *Hakea francisiana*. There were up to 40 children involved and Alison commented that the more adults supervising the children the better the planting went. She also thought it would be better if the children were billetted on farms rather than staying as a group in the local hall. In each year two or three adults, but no children, collected seed for the growth of the subsequent year's seedlings. These plantings involved many of the local and visiting community.

No planting was done in 2001 and the farm has now been sold. The site was visited on July 28, 2001, and an assessment made of the success of the plantings. The site was in two parts, the blowout with bare sand and the adjoining high ground to the south that was very weedy. We counted all the dead and living plants that we could find, and confirmed that some of each species planted had survived. In the blowout we found 603 (88%) living plants and 84 (12%) dead plants. In the weedy section to the south we found 276 (45%) living plants and 340 (55%) dead plants. The number of dead plants is a minimum, of course, because over five years many dead plants will have disappeared without trace, but the comparison between the two sites is useful information, indicating the damage done to plantings by competing weeds. Assuming an average of 700 seedlings were planted each year, as suggested by Alison, 879 survived out of 2800, that is 31%. Nevertheless, this will provide a useful stand of food plants in an area of about 10ha.

Elizabeth Eaton has been kind enough to provide details of planting in the Guilderton area, coordinated by herself and the Lower Moore Catchment Rehabilitation Working Group, between 1996 and 2001, in conjunction with North Beach Primary School, Central Midlands Senior High School, other schools, local residents and the Men of the Trees. These plantings were in Silver Creek (SC), the Catholic land adjacent to Guilderton (CL), the Guilderton Road turn off (GR), Guilderton townsite (TS), Gingin Shire Council land leased by Bowra and O'Dea (BD) and Lancelin Road bridge over the Moore River (LR). Information about these plantings is shown in Table 4 below.

Table 4: Success of tree plantings in the lower Moore Catchment.

Date	Place	Number and species	Success
1996	SC	500 - mixed including *Melaleuca cuticularis* and *M. rhaphiophylla*	Unknown
1997	SC	500 - mixed	Unknown
1998	GR	500 - mixed: *Eucalyptus erythrocorys*, *E. gomphocephala*, *E. torquata*, *Banksia victoriae*, *Hakea spp.*, *Calothamnus quadrifidus*, *Templetonia sp.*	250 survived first summer
	TS	50 around Guilderton Hall	Mowed
1999	CL	500	Eaten by sheep
	TS	20 *Eucalyptus gomphocephala* in Wedge Street	11 survived
	SC	28 *Eucalyptus gomphocephala*	Unknown
2000	BD	3000 - mixed	Good survival - some rabbit damage
	SC	40 - *Eucalyptus rudis*, *Melaleuca cuticularis* and *M. rhaphiophylla*	Unknown
	LR	350 - mixed including *Eucalyptus gomphocephala*, *E. rudis*, *Melaleuca cuticularis* and *M. rhaphiophylla*	Some survival
2001	SC	650 - mixed	Unknown
	GR	500 - mixed	Unknown
	CL	5000 - mixed	Unknown

Three conclusions are apparent. Planting by school children and community members can make a useful contribution to food resources for Carnaby's Cockatoo if appropriate plant species are utilised; survival of seedlings is poor unless conspicuously protected from human activity (e.g. mowing) and herbivores; seedlings survive poorly without continuing weed control.

Artificial nest sites for Carnaby's Black-Cockatoo

Carnaby's Black-Cockatoo faces severe competition for nest sites from bees, Little and Western Corella, Galah and, to a lesser extent, Australian Shelduck. Saunders (*pers. comm.)* has found that a single cyclone can destroy 30% of the available nest hollows in a remnant, and it would clearly be beneficial for more nest sites to be available. Previous efforts to create artificial nest sites have not been successful, but in the course of this project Wally Kerkoff of Moora was visited. He is a farm worker who lives on a town block near the outskirts of Moora, and has a great interest in Carnaby's Cockatoo. He described and demonstrated his success in "managing" a local flock of wild birds. He has fed the birds for a number of years and finds that they are attracted by grey, not black, sunflower seed, one minute oats, corn cobs, peanut butter, almonds and "Coon" cheese. One evening in August when I visited him, he had 83 wild Carnaby's Cockatoos in the trees in his quarter acre block waiting to be fed.

Kerkoff has developed an artificial nest for the birds and erected five on his quarter acre block. All are occupied by breeding pairs of Carnaby's Cockatoo simultaneously, and chicks have been successfully raised in them. Figure 1 shows a diagram of his artificial nest. Briefly, it is mounted

on a six metre pole of 3 inch piping, the base firmly cemented into the ground. At the top a plough disk or iron frame supports a hollow log up to one metre high, with a cavity at least 25 cm in diameter. The top is covered with an aluminium sheet and a side entrance is provided near the top and about 12 cm square. No other perch is provided. Potting mix is put in the bottom, in a layer about 12 cm deep.

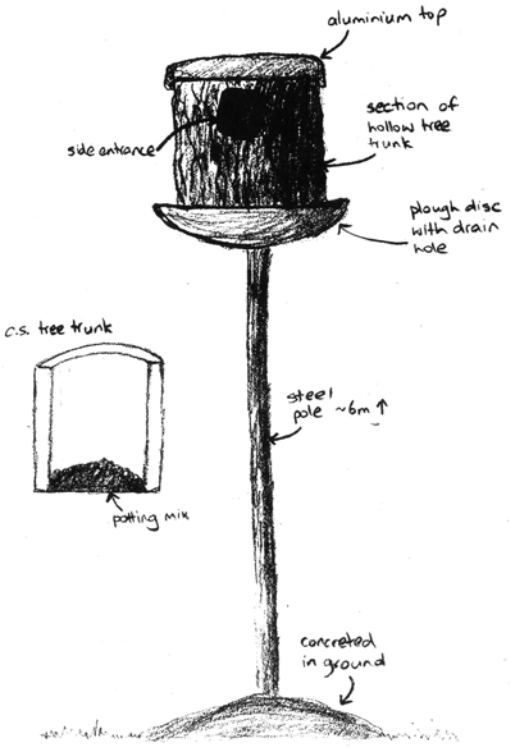

Figure 1: Diagram of an artificial nest box for Carnaby's Black-Cockatoo developed by Wally Kerkoff.

Kerkoff's knowledge is a valuable resource, and his unconventional approach in some matters should not detract from his obvious skill in getting "under the bird's skin". He has demonstrated that successful artificial nest sites can be made.

How far will breeding male Carnaby's Cockatoos travel to feed?

Once the female Carnaby's Cockatoo has laid her first egg she will sit on the nest and remain there fed twice a day by the male. The male continues to feed her throughout the 28-29 day incubation period (Saunders, 1982) and for the first two to three weeks of the nestling's life. It follows that while he is thus supporting his mate and family, food must be available within a reasonable distance, and in sufficient quantity to support this behaviour. Saunders (1980) work indicated that the males would travel a mean of 2.5 km to a food source. If plantings are to be made of food plants for Carnaby's Cockatoo then they should be within the range that breeding males are able to travel. This aspect of the project sought to determine how far males were travelling from known nest sites.

Wally Kerkoff's opinion was that males would travel at least 2 km to find food. Investigations were conducted during the project in the Coorow Shire, from nest sites on two local farms. Seven people were involved in the studies, that were made between October 8 and 11, at a time when, of the two nests inspected in detail, one had two eggs and one had a chick less than one week old. The participants are very grateful to local landholders who allowed access to their

properties and made accommodation available, and to Whiteman Park in Perth, who kindly lent two way radios which were invaluable.

The study concentrated on two groups of nests. From the salmon gum timber belts at Property A, the males were travelling west along the salt creek to feed on the *Erodium* (Corkscrew, Crane's Bill) seed heads at Property B, 12 km away. The feeding flock contained 54 males; only four females were seen, suggesting that the number of nests in the Property A timber was at least 50. These birds were able to travel almost all the way over natural vegetation in which they sometimes stopped to feed on *Hakea preissii* fruits. At Property C, where there were two known nests, the birds went north, about 6 km but over open paddocks, although they followed tree lines whenever they could. The birds were travelling to a remnant on a third property, where various *Hakeas* and *Acacias* were fruiting. These distances mean that effective plantings of food plants can be made some distance from nesting areas, especially if corridors of vegetation are established between nesting area and food site as emphasised by Saunders (1980).

The birds travelled singly from the nest but tended to form flocks on the way to and from the feeding grounds. Thus flocks of 35, 15 and 15 were seen to arrive at Property A on the two mornings that site was covered. Watching from Property A in the morning flocks of 10, 9, 7, 5, 5, 5+3 were seen flying west to the feeding grounds and, later in the morning returning flocks of 7, 7, 9, 5 were observed reaching the Property A woodland. Even the Property C site birds formed small flocks of up to 5 individuals when moving over the open paddocks. Flocks of these sizes may, therefore, involve nesting birds from a considerable area, and should not be taken to imply that a large number nest in the immediate vicinity of the site where the flock is seen.

Future work

There are two aspects that have shown up during this consultancy which would merit further work. First the artificial nest site design should be tested on a field scale, to see if the birds will accept them in remnant wood lots and new plantations. A preliminary study of this aspect is now in progress through Men of the Trees, with support from WWF-Australia's Threatened Species Network.. In 2003, 43 artificial nest boxes of the Kerkoff design have been distributed over eight sites in the Moora, Watheroo, Coorow and Calingiri areas. They will be monitored by the landowners to see if they are successfully adopted by wild Carnaby's Black-Cockatoo.

Secondly, it would be of considerable value to determine how large an area of food planting is needed to support a breeding pair of cockatoos.

Summary

The project Carnaby's Cockatoo - Coast and Catchment has, for the Moore River Catchment:

- Identified most of the groups contributing voluntary effort to improve the conservation status of the bird;
- Established contact with statutory and private stakeholders;
- Examined the planting techniques used by volunteers;
- Measured the natural spacing of mature trees of species significant to the cockatoo;
- Identified future research required in relation to the size and distribution of plantings of potential food plants and the possibility of creating artificial nest sites;
- Examined the survival of plantings made to benefit Carnaby's Cockatoo in a semi-protected planting (about 30% over 5 years);
- Identified the design of a simple, successful artificial nest box for the species;
- Shown that breeding males will travel at least 12 km to a feeding site connected by a corridor to a breeding area, and at least 6 km to a feeding site separated by open fields from a breeding area.

Recommendations

The results of the project indicate the value of implementing the following recommendations. These cover three distinct fields of operation:

1. The involvement of volunteers in germinating, growing and planting food and shelter species.
    - When volunteers come into the field to plant they should be accompanied by several experienced planters;
    - The layout of the planting should be clear before planting starts;
    - Visiting volunteers should be billetted with local residents wherever possible, rather than accommodated as a group in a local hall.
2. The design and execution of plantings aimed at improving the conservation status of the bird:
    - Large gum trees should be widely spaced when planted, with seedlings 15-20 m apart, to ensure rapid, vigorous growth;
    - Small headlands at the corners of paddocks, omitted from cropping but able to support three or four large gums should be targetted for the planting of future nesting trees;
    - Large eucalypts should not be planted within remnants, but at their edges;
    - Food plants, such as banksias and other Proteaceae, should be planted in blocks or corridors of several hectares, so that they produce sufficient fruit to sustain a local population for some weeks. Banksias should be planted at least 10 m apart;
    - All seedlings should be protected from rabbits and kangaroos with tree guards. More is achieved by planting few, well-protected seedlings than many unprotected ones;
    - As far as possible weeds should be controlled within plantings.
3. Measures directly aimed at assisting the birds' survival and reproduction:
    - Corridors should be planted to connect breeding sites with feeding sites. Uncleared salt creeks are adequate corridors. Nesting birds will travel at least 12 km each day along such corridors to feed;
    - The birds will use artificial nest sites; these should be erected in areas where there is ample food but few nest sites, for example in young plantations.
    - Nest predators and competitors, bird trappers, cats, honey bees, galahs and corellas, should be controlled;
    - Artificial feeding of birds near nest sites, particularly with grey sunflower seed, can encourage nesting, but feeding stations need to be protected from galahs and corellas.

ACKNOWLEDGEMENTS

I am grateful to Danika Loomes who worked with me throughout the project, to Christine Cooper who undertook the analysis of the seeds and to the people who helped to track the birds from nest sites to feeding areas, Emily Clements, Melanie Clinch, Christine Cooper, Alison Doley, Fiona Falconer and Brenden Metcalf. Elizabeth Eaton and Alison Doley provided valuable information about previous plantings, and Wally Kerkoff showed me his nest boxes and told me much about Carnaby's Black-Cockatoo. The cooperation of landowners, agency staff and Landcare officers has been greatly appreciated.

Carnaby's Black-Cockatoo Recovery Project: Recovery Actions in the Western Australian Wheatbelt

Leonie McMahon
Birds Australia WA

The current stage of the Carnaby's Black-Cockatoo Recovery Project began in August 2001 with funding from the Natural Heritage Trust. The main purpose of this stage of the project is to implement several of the recovery actions outlined in the Carnaby's Black-Cockatoo Recovery Plan. Birds Australia Western Australia is represented on the Carnaby's Black-Cockatoo Recovery Team and works in close conjunction with it.

The main objectives of the project are to raise public awareness about the plight of the Cockatoo and to assist landholders to manage their breeding populations in key breeding areas.

Actions to raise public awareness include attending agricultural shows & field days in areas where the cockatoo is found and conducting presentations to groups including Landcare Groups, rotary clubs, schools. They also include media coverage through community newsletters, regional newspapers, metropolitan newspapers, special interest journals, radio interviews and electronic newsletters.

The process of identifying breeding sites in the wheatbelt that would be the focus of recovery actions, i.e. nominated key breeding sites, was the main objective of the first year of the project. Initial information about the location of breeding sites came from several sources including a survey conducted in an earlier stage of the BAWA project in the latter half of 2000. The 2000 survey sought information from the general public about the cockatoo's range during the breeding season. Other sources of information were anecdotal and historical CALM and CSIRO records, including the records made by Dr Denis Saunders during his years of research into the breeding ecology of the species. The earlier Birds Australia project brought to attention some breeding areas that hadn't been generally known previously and these were also further investigated.

Many wheatbelt breeding sites are on private farmland, while others are found in the conservation estate or crown land, in roadside vegetation and within rural townsites on public and private land. Six key breeding areas were selected to be the focus of recovery actions, five in the northern Wheatbelt and one in the Great Southern. The sites were selected using a number of criteria including the estimated size of the breeding population, the types of threats facing the site and the level of involvement of farmers and local communities

Research conducted by Dr Denis Saunders has demonstrated that a critical factor in breeding success is the close proximity of feeding habitat to the breeding hollow. It is recommended that existing remnants be linked with corridors or that 'stepping stones' of vegetation be provided that are within sight of each other for the species to move between remnants (Saunders & Ingram, 1987). Efforts are thus made to identify the corresponding feeding habitat for each breeding site and these feeding sites are then considered when managing the site. Often the cockatoos can be breeding on one property but feeding on another so it is evident that an approach that calls for cooperation between landholders is ultimately the most effective conservation strategy.

Project activities at key breeding sites

There are several important ways in which the Birds Australia WA project assists landholders and other stakeholders in managing key breeding areas. These include:

- Identifying and monitoring active breeding hollows and associated feeding sites. Monitoring is undertaken by a variety of people, depending on the landholder's

preference, and includes landholders, members of local communities, Birds Australia WA volunteers, the Birds Australia Project Officer and CALM staff;

- Showing interested landholders the techniques used to identify critical breeding and feeding habitat, and to identify, monitor and record breeding activity using monitoring sheets;
- Providing information about recovery actions to landholders and other stakeholders. This is provided verbally, through the provision of information sheets, presentations at field days and other pubic forums, attendance at agricultural shows, publication of *Cocky Notes,* a regular bi-annual newsletter, and by coordinating field days to disseminate information. The information sheets cover a range of topics including general information about the species, threats, recommended recovery actions and monitoring guidelines and monitoring sheets;
- Providing information to other stakeholders and assisting with recovery projects, on-ground recovery actions and funding applications,
- Maintaining a secure database of breeding activity at key breeding sites.

Recovery actions at key breeding sites vary depending on the needs at any given site but they generally include a combination of some of the following:

- Protection of known feeding and breeding sites through fencing or excluding stock, controlling weeds, protecting against firewood collection and changing inappropriate burning regimes;
- Revegetation of known feeding and nesting sites with appropriate plants. These include Proteaceous species such as *Banksia*, *Hakea*, *Grevillea* and *Dryandra* as food sources and Wandoo *Eucalyptus wandoo* and Salmon Gum *E. salmonophloia* in particular for future nesting hollows;
- Repair and maintenance of old and damaged nesting hollows. Hollow repair includes covering cracks and splits in wood near the nesting chamber, ensuring the entry and chamber are clear of blockages, removing dead carcasses and old or addled eggs, shoring up 'blow-outs' at the bases of trees and refilling emptied hollows with 'mudguts', the material naturally found in hollows;
- Leaving dead eucalypts standing. Carnaby's Black-Cockatoo often nests in dead trees;
- Controlling nest competitors such as Little and Western Corella, Galah and feral honeybees. Such control may be subject to appropriate approvals;
- Creation of corridors of suitable vegetation between areas frequented by Carnaby's; and
- Monitoring of breeding activities of the cockatoo.

Within each of the key breeding areas, recovery actions are being carried out in different ways, depending not only on the nature of the breeding sites but also on what best suits the landholders and communities concerned. At some sites individual landholders carry out recovery actions on their own properties while in other areas a more broadscale approach is taken by Landcare groups. For example, the New Norcia-Calingiri landcare group 'Cockys for Landcare' has adopted Carnaby's Black-Cockatoo as its emblem and makes a concerted effort to link recovery work for the species to its landcare objectives (Young & Mason, this volume). More widespread approaches may also be undertaken by rural shires, e.g., Shire of Moora, and groups of concerned landholders.

Key stakeholders

Efforts to assist Carnaby's Black-Cockatoo come from a diverse range of stakeholders including individual landholders, Landcare groups and coordinators, rural shires, community groups, Government agency staff, particularly the Department of Conservation and Land Management (CALM), corporate sponsors, schools and Birds Australia WA. Funding bodies such as the Natural Heritage Trust, Lotteries West and WWF-Australia's Threatened Species Network also play a role.

The benefits of working with conservation and natural resource management professionals operating in the key breeding areas – e.g., Landcare coordinators, Land for Wildlife officers and CALM staff - have been considerable. Their local knowledge, conservation expertise and coordinating roles make them an invaluable resource, one that can greatly assist with the implementation of recovery actions. Other potential stakeholders include the regional Natural Resource Management groups, catchment groups and programs such as WWF-Australia's Woodland Watch.

An example of a community group project is one recently carried out by the Million Trees Program, a division of Men of the Trees. The Program has received funding through WWF-Australia's Threatened Species Network to carry out a planting program and nesting box trial for Carnaby's Black-Cockatoo and additional funding from Rio Tinto to carry out a second planting program. Local provenance seedlings were grown by Million Trees and two wheatbelt nurseries and planted out in the wheatbelt by metropolitan students. As a result, in the 2003 tree growing season the group planted about 35,000 seedlings in the wheatbelt in areas known to be used by Carnaby's for either feeding or breeding habitat or the creation of corridors. The program is an important educational tool for school students. It is also a way of contributing to revegetation of critical habitat and a means of developing public awareness in the broader community. An important element of all such tree plantings should be monitoring and evaluation. A record of information about the plantings, including the number and species planted and details of the planting site and survival rates should be kept.

Perceptions of the status of Carnaby's Cockatoo

People tend to equate large flocks of cockatoos with a viable population. It is possible still to see large numbers of Carnaby's Black-Cockatoo in some areas, although numbers have dwindled in many other areas and the cockatoo is locally extinct in approximately one third of its previous range. Because of this visibility, members of the public sometimes question the cockatoo's status as endangered.

In relation to the apparently large numbers of birds, it is important to remember that breeding pairs of Carnaby's Black-Cockatoo migrate between their winter breeding grounds and summer feeding grounds and this can give the impression that more birds exist than actually do. The cockatoos tend to congregate together during the non breeding season so the large flocks seen may come together from many different areas. They are present in large numbers at some remaining feeding sites, for example Yanchep National Park and the Gnangara pine plantations, because they have limited options.

Carnaby's Black-Cockatoos are long-lived birds, living up to 40-50 years in the wild. It is believed the current population of Carnaby's Black-Cockatoo is an aging one because recruitment of young birds into the population has decreased so much (Cale 2003). If this were so, when the older birds die there would be a crash in numbers from which the species might never recover.

Funding issues

The current uncertainty surrounding the future of funding for conservation works impacts directly on the effectiveness of the project by reducing funding options for the project itself and contributing to the loss of experienced Landcare coordinators in key breeding sites.

In the case of the Birds Australia project, the time and effort required to source funding to keep the project operating is considerable and is done at the expense of other work such as implementing on-ground recovery actions. The short-term nature of most funding also makes it difficult to plan and carry through medium or longer-term strategies.

The loss of conservation professionals in key areas means a loss of continuity and local knowledge and expertise. In addition, the landholders themselves lose access to a person able to source funding for on-ground recovery actions and to help coordinate recovery efforts.

On-ground recovery actions such as fencing critical habitat and revegetating with appropriate species are expensive for landholders, and sourcing adequate funding is an issue. Short lead-times for writing and submitting funding proposals, the short-term nature of funding and the lack of consideration given to factors such as drought and flood that may affect the implementation and/or outcomes of these on-ground actions are all factors to be taken into account.

Public Interest in the Cockatoo

There is much public interest in the welfare of this species, both in the Perth metropolitan area, and throughout the wheatbelt and regional WA. Obviously this interest opens up a number of opportunities but at the same time creates a number of challenges. The main challenge is the translation of that interest into actions that are going to be meaningful for the people concerned but also of real benefit to the cockatoo, whether those actions be in breeding or non breeding areas .

There is a need to manage that public interest so that people are well informed about the recovery actions that will be most effective in their circumstances. People also need to be well informed about other recovery efforts in their area so that overlaps can be minimised and efforts pooled, thus making the most of scarce resources. In addition, it is important that recovery actions are carried out with reference to the official Recovery Plan and ad hoc projects and actions are avoided. Recovery projects and their outcomes need to be recorded by a central body so that overall outcomes can be evaluated, the broad picture of events formed and gaps in recovery efforts identified.

An example of a 'gap' that arises regularly through phone calls from members of the public is clearing, usually for urban development, in the Perth Metropolitan Region. Examples include the Burns Beach and Underwood Ave developments. Both of these areas of bushland are feeding grounds for Carnaby's Black-Cockatoo. Some questions arise from land clearing and urban development in the non-breeding range of the Cockatoo. These include the degree of impact on the species and the methods by which these impacts might be assessed and examined in the context of the Recovery Plan. Mitchell (this volume) has discussed the uncertain impact on Carnaby's Cockatoo of the clearing of the Gnangara pine plantations.

As the current scope of this project is limited to recovery actions in the wheatbelt, it is beyond its scope to adequately deal with these issues but the regularity with which they come to the fore is an indication of the concern people have for the cockatoo.

Conclusion

As a species, Carnaby's Black-Cockatoo lends itself very much to flagship species status. Recovery actions carried out in its name also benefit the two very different habitats that it relies on for breeding success in its breeding range, eucalypt woodland and kwongan heath, and also benefits other species that rely on those habitats. It is with this additional incentive that the Birds Australia WA project continues its work in the wheatbelt.

Conserving Carnaby's Black-Cockatoo: Conservation Actions in a Rural Shire

Peter Stubbs
Shire of Moora

The Moore River Catchment lacks and needs conservation focus. An iconic species like Carnaby's Black-Cockatoo can provide that focus, and help to develop more conservation-orientated attitudes amongst people and communities in the Catchment. That would be good not just for Carnaby's Cockatoo but also for the whole natural environment of the area.

Moora is the largest community in the Moore River Catchment and is recognised a significant nesting area for Carnaby's Cockatoo The advantages Moora has in terms of the Carnaby's Cockatoo Recovery Plan need to be capitalized on if we are dinkum about the recovery effort. Equally the challenges in and around Moora need to be met through local action.

Local resident Wally Kerkoff has a wealth of knowledge about Carnaby's Cockatoo that could be harnessed in the Moora Shire contribution to the state recovery program. His work with artificial nesting hollows is significant given the rate at which nesting hollows will be lost in the future.

The CY O'Connor Salmon Gum Community Nursery is another asset the Moora community has to offer the Carnaby's Black-Cockatoo recovery program. Through this nursery, local provenance plant species can and are being produced for revegetation projects aimed at both feeding and future nesting sites for the cockatoo.

Challenges in conserving Carnaby's Black-Cockatoo in the Moora area

- Diminishing feeding sites for the cockatoos;

Diminishing nesting sites for the cockatoos. Storm damage, waterlogging, salinity and bush fires all conspire to reduce the number of nesting sites;

- Competition from Corellas, Galahs, and feral honeybees for nesting hollows place considerable extra pressure on the cockatoo and will need to be managed if we to want to ensure better breeding opportunities for the species;
- Low degree of public awareness.

Shire of Moora Carnaby's Cockatoo Recovery Program

The following are planned under the Moore Recovery Program:

- Public awareness: establishment of the 'Carnaby's Cockatoo' interpretive walk trail. This trail, currently under construction, is to be 4km long It will traverse the Moore River valley from the Chert hills east of Moora where Carnaby's Cockatoo both feed and breed, along the Moore River, under Salmon Gums, through to the sand hills west Moora where Carnaby's Cockatoos feed on pines and banksias;
- Increasing public awareness of the endangered status of the cockatoo and issues related to it;
- Linking the conservation goal with the goals of tourism and business so that the cockatoos are valued more. If that link is not made then we weaken the support base for the recovery effort;
- Involving the education sector and community groups;

- Installation of artificial nesting sites in Moora. How far can we take the installation of artificial nest boxes? How far will we need to take this measure? There could be several hundred installed in the Moora Shire with a bit of effort;
- Establishing a local Carnaby's Black-Cockatoo Recovery taskforce.

Habitat preservation and enhancement

Identification of areas for revegetation for feeding sites and future nesting sites;

- Prevention of vehicle access to remnant Salmon Gum sites;

The re-classification of valuable unmade Road Reserves to conservation reserves;

Management of Corella and Galah numbers in the Moora shire. We have to get used to the idea that in order to preserve one species we have to manage another! We live in a highly modified environment. And we are now responsible to trying to keep some balance in the system around us, given the level to which we have modified it.

Project partners

- Local Government – Shire of Moora;
- Local community;
- Department of Conservation and Land Management;
- Birds Australia WA;
- Cockatoo Care (Water Corporation);
- Natural Heritage Trust/Northern Agricultural Catchment Council/Moore River Catchment Council;
- Trails West;
- Country Pathways;
- Corporate sector;
- Private sector;
- Men of the Trees;
- CY O'Connor TAFE;
- Schools/youth.

Resourcing for this project is untapped. Rio Tinto involvement might just be the start. We need some things on ground for the sponsor to see before they get excited. They need to see what is in it for them.

Future expansion: private land

Change of attitude towards volunteer work and funds on private land.

WWF-Australia's Woodland Watch Project: Relevance for Carnaby's Black-Cockatoo

Mick Davis
WWF-Australia

Introduction

Woodland Watch is a project of WWF Australia, operating in the central and northeastern Avon Wheatbelt (IBRA v5.1) of Western Australia. Project officers aim to work with interested landholders to protect tall Eucalypt woodlands on private property. The project aims to assist landholders to engage in conservation management activities within remnant vegetation, and to facilitate long-term protection measures including Voluntary Management Agreements and Nature Conservation Covenants.

Project officers work regionally from the Wheatbelt towns of Northam and Bencubbin. This means that they are close to and part of the farming community, making them more accessible to interested landholders. Working face-to-face with various stakeholders, project officers are able to present a range of options for the long-term protection of woodlands and associated remnant vegetation to farmers, and assist in the implementation of such measures.

Photo: Leonie McMahon

Figure 1: Wandoo woodland in the Western Australian wheatbelt, with typical Carnaby's Black-Cockatoo nesting hollow.

What Makes Woodland Watch unique?

Our project focuses on farmers with Salmon Gum *Eucalyptus salmonophloia*, Gimlet *E. salubris*, Red Morrel *E. longicornis* and York Gum *E. loxophleba* woodlands, as these species are under-represented in the conservation estate, and have been selectively cleared in the agricultural landscape. Within the Western Australian wheatbelt, less than 10% of the original extent remains of these woodland types of tall eucalypts.

Initial contact with landholders is usually through local Community Landcare Coordinators, but can also come as a result of a private telephone enquiry or a GIS desktop survey. A major asset of Woodland Watch is that project officers are encouraged to visit landholders on their properties at a mutually agreeable times, and are proactive in seeking new participants. While on-site, they are able to outline any threatening processes that are active in the remnant, as well as point-out potential threatening processes that may need monitoring or attention.

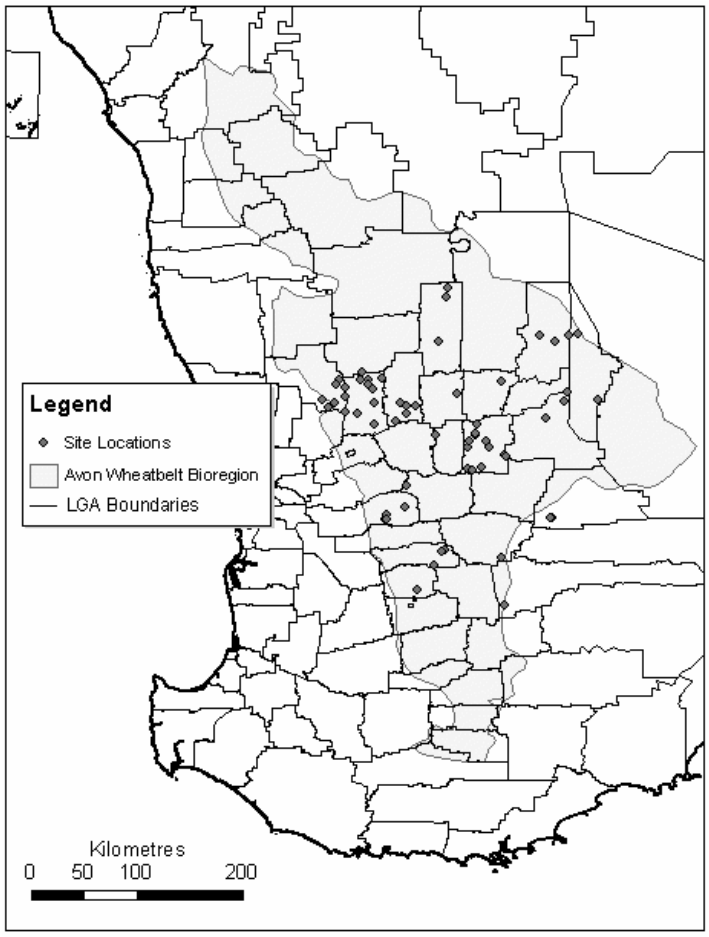

Figure 1: Woodland Watch sites in the Avon Wheatbelt IBRA region. Map courtesy of the Western Australian Herbarium.

The Negotiation Process

Woodland Watch presents landholders with a selection of methods for addressing a range of threatening processes that occur within woodlands, such as weed invasion, fragmentation of the bushland, feral animals, erosion and wildfire.

Through this process, the project provides landholders with vital links to local and regional landcare bodies, which can facilitate the desired management options that farmers want to

implement on their land. The process begins with initial contact and a meeting with the landholder, and proceeds to a negotiation related to management actions, and discussions on long-term management options.

Long-term Management Options For Private Land

For landholders who are interested, for any number of reasons, in protecting the biodiversity values of their remnants, Woodland Watch is able to 'broker', at no cost, a range of long-term management options that are best suited for each individual landholder. Depending on the level of commitment expressed during site visits and on-going contact, and based on information provided by the project officer, the most appropriate option for protecting the bush in the long-term is decided upon by the property owner.

Currently in Western Australia there are two main mechanisms that ensure the protection of bush in the long-term. These are Voluntary Management Agreements and Nature Conservation Covenants.

Voluntary Management Agreements

VMAs provide management guidelines that will be used by the landholder in the on-going protection of an area's biodiversity. They are non-binding on the land title, and are generally considered as a 'medium level' of commitment to biodiversity conservation. In most cases they set out what measures will be used to manage the bush as part of an ongoing farm plan.

There are a number of conservation organisations that offer Voluntary Management Agreements, and the final decision as to which one is most appropriate is up to the landholder. The two most commonly used in the Western Australian Wheatbelt are managed by the Department of Conservation and Land Management's Land for Wildlife program, and WWF-Australia's Woodland Watch program.

Occasionally, Voluntary Management Agreements are offered as a condition of funding, such as the Commonwealth Government's Natural Heritage Trust (NHT) Envirofund grants. Agreements might also be entered into between a local Land Conservation District Committee (LCDC) and a private landholder.

Conservation Covenants

A Nature Conservation Covenant is a voluntary agreement between a landowner and an authorised body, to help the landowner protect and manage the environment on their property. It is usually registered on the title of the land and can apply to all or part of a property. Although there are exceptions, it is usually permanent.

Conservation covenants allow interested private landholders to demonstrate the 'highest level' of commitment to nature conservation in Western Australia. By placing a conservation covenant on their property, landholders are acknowledging that the land has high biodiversity values and that they wish to see those values protected in the long-term.

This means that when the land is sold, or otherwise changes owners, the conditions set out in the conservation covenant travel with the title of the land, and are binding upon the new owners.

What's the Response in the WA Wheatbelt?

From its launch in July 2000 until mid-2003, Woodland Watch has seen 87 landholders with high-quality woodlands participating in the project, with each one having a detailed flora survey within the woodland area together with on-going support for the management of their remnant vegetation.

As a result, 40 landholders have either implemented or initiated conservation covenants, Land for Wildlife agreements and other voluntary conservation agreements.

In total, to mid-2003, 4,626ha (11,565acres) of bush has been placed under various conservation agreements through landholders involved in the Woodland Watch project.

Almost 46% of the landholders engaged in the project have gone on to establish long-term management of their remnant vegetation. This is a demonstration of the commitment that private landholders have to protecting biodiversity on their own land, and provides landholders interested in joining the project with a body of peers with which to discuss concerns and compare success stories.

How Does Woodland Watch Link with the Carnaby's Black-Cockatoo Recovery Project?

- The Woodland Watch Project is focused on helping landowners manage their tall Eucalypt woodland remnants, specifically Salmon Gum, York Gum, Gimlet and Red Morrel remnants. Carnaby's Cockatoo prefers to nest in old Eucalypt woodland, primarily Salmon Gum and Wandoo. Therefore, by protecting areas of Salmon Gum and Wandoo woodland on private property in the WA Wheatbelt, Woodland Watch helping to protect breeding habitat in the long-term.
- The planned expansion of the Woodland Watch Project into the northern agricultural zone in late 2003 will allow a new project officer to begin working with landholders to help them protect tall Eucalypt woodlands on their private property. Some of the prime nesting habitat for Carnaby's populations occurs in this northern Wheatbelt region, and as a result it is expected that some of these areas will be protected in the long-term via Voluntary Management Agreements and Nature Conservation Covenants.
- By increasing the awareness of the threatening processes that occur within woodlands and other remnant vegetation, Woodland Watch is helping farmers protect the breeding and feeding habitat of Carnaby's, which are dependant on remnant vegetation for food, nesting sites and shelter.
- And finally, because Woodland Watch works exclusively with private and non-state estate landowners, the project adds to the efforts of various government and other non-government agencies that are also working towards protecting Carnaby's Cockatoo habitat into the future.

Other Relevant WWF Projects

WWF Australia has another project that is relevant to the protection of Carnaby's Cockatoo in WA. This is the Threatened Species Network (TSN). TSN is a joint program between WWF-Australia and the Australian Government's Natural Heritage Trust that empowers the community to take action to protect rare and threatened species all over Australia. In WA, in relation to Carnaby's Black-Cockatoo, TSN has provided assistance in trialing the effectiveness of artificial nest boxes as a means of habitat compensation in partnership with Men of the Trees and Professor Stephen Davies, and has helped Men of the Trees to restore and create feeding and nesting habitat for Carnaby's Cockatoo in the wheatbelt. The Threatened Species Network is also represented on the Carnaby's Black-Cockatoo Recovery Team and works in collaboration with the Birds Australia Carnaby's Cockatoo Project Officer.

Conservation of the Carnaby's Black-Cockatoo: A Land for Wildlife Perspective from the northern Wheatbelt

Fiona Falconer
Department of Conservation and Land Management

Introduction

I work as a Land For Wildlife Officer in the northern wheatbelt of Western Australia. The Land For Wildlife scheme, which is operated by the Department of Conservation and Land Management, aims to assist landholders in integrating nature conservation with other uses of land. My area encompasses the Shires of Northampton, Chapman Valley, Irwin, Mingenew, Three Springs, Carnamah, Coorow, Moora, Wongan-Ballidu, Dalwallinu, Perenjori, Morawa and Mullewa.

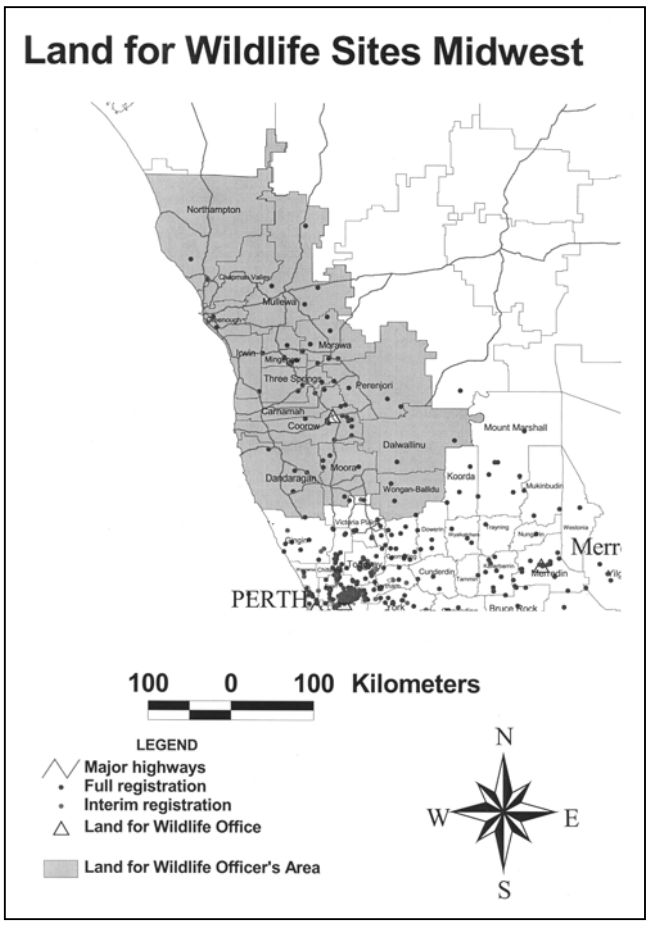

Figure1: map showing the distribution of Land for Wildlife properties across the northern wheatbelt region.

As at 1st June 2003, 70 properties had registered with Land For Wildlife in the northern wheatbelt region, with 60 properties visited and receiving completed Property Assessments. Most registered properties are broadacre agriculture farms.

Some relevant statistics for Land for Wildlife properties in my area in mid 2003:

- The total area of properties registered and visited is 71,948 hectares;
- The total area of remnant vegetation on those properties is 17,935 hectares;
- The total area of designated Land For Wildlife sites is 13,647 hectares.

The distribution of Land For Wildlife properties across the Northern Wheatbelt region can be seen from the map.

Following registration, all properties are visited, which provides the opportunity for landholders to have a 'one on one' discussion of their nature conservation issues. It also allows for the establishment of a photopoint monitoring site and general 'rapid technique' assessment of flora and fauna in remnant vegetation.

Geology and vegetation of the region

Most of my Land For Wildlife area covers parts of 2 major geological structures, the Perth Basin and the Yilgarn Craton (Alderman & Clarke, 2003). The Darling Fault separates the Perth Basin in the west from the Yilgarn Craton in the east. These areas include vegetation typical of the Geraldton Sandplains and the Avon Wheatbelt (Beard, 1990). For the purposes of this discussion I will be referring to Land For Wildlife properties as being located in either the 'west' or 'east', corresponding approximately to their location either west or east of the Darling Fault in either the Perth Basin or Yilgarn Craton respectively.

The properties

Of the total number of Land for Wildlife properties visited in the region, property assessments note a total of eighteen landholders having observed Carnaby's Black Cockatoos on their properties. Eleven observations were on properties in the 'west' and seven in the 'east'. Two of the 'east' observations were 'old'- that is, anecdotal information recounting memories of Carnaby's Cockatoo nesting or 'being around'.

Observations of the birds included:

- Nesting;
- Nesting and feeding;
- 'Flying over';
- Feeding.

Some of the observations were made on the Land for Wildlife visit itself, where landholders were pleasantly surprised to find Carnaby's Black-Cockatoo present. Many landholders rarely find the time to really explore their bush areas, to 'look and listen' for what may be there. Once familiar with the Carnaby's call, it is a giveaway to their presence.

The early settlers were astute in their selection of land for agriculture. The land to the east of the Darling Fault, with its fertile soils associated with eucalypt woodlands, has had a longer history of agriculture. Extensive clearing dates back to the 1920s for many Land For Wildlife properties in that area.

In contrast, many Land for Wildlife properties in the west, with poor sandy soils associated with banksia low woodlands and other sandplain vegetation types, were not cleared until the 1950s-1960s. This coincided with the development of leguminous pastures and the use of fertilisers to enrich soils. Consequently, the landcare and conservation issues facing landholders in the east and west differ in type and priority.

The landholder priorities for these landcare and conservation issues will dictate, to a large extent, the future for the Carnaby's Black-Cockatoo in the region.

Issues for landholders

'West' (Perth Basin):

The main farming enterprise in the west has, historically, been sheep grazing. In recent years, cropping and the grazing of cattle in combination with sheep have been increasing.

There are a number of landcare and conservation management issues in this area. They are:

- Fencing of remnant vegetation;
- Revegetation to address wind and water erosion. This may include biodiverse plantings and/or commercial plantings (fodder shrubs, farm forestry, etc);
- The need to increase the knowledge of flora and fauna on the property;
- Management of remnant vegetation, (e.g., appropriate fire regimes to encourage regeneration);
- Control of problem native fauna (e.g., Western Grey Kangaroo), and feral animals (e.g., fox);
- Control of weeds (e.g., Paterson's Curse);
- Decline in health of isolated paddock trees.

Some management issues specifically relate to Carnaby's Black-Cockatoo:

- Degradation by grazing of unfenced remnant vegetation, including large blocks, corridors left along fencelines and isolated paddock trees - leads to reduced value of feeding sites and increased vulnerability to predation where corridors and paddock trees no longer provide safe passage for the birds' movement across a predominantly cleared landscape;
- Invasion and occupation of nesting hollows by feral bees;
- Plants used in revegetation, and how they may benefit or disadvantage Carnaby's Cockatoo;
- Nest robbing.

'East' (Yilgarn Craton)

Historically, farming enterprises in the east have been 'mixed', with a combination of cropping and livestock. The 'mix' has fluctuated, and will continue to fluctuate, in response to commodity markets.

There are a number of landcare and conservation issues in this area:

- Fencing of remnant vegetation;
- Revegetation to address rising watertables and salinity and establish corridors to connect fragmented remnants of vegetation;
- Species for revegetation;
- The need to increase knowledge of flora and fauna;
- Management of remnant vegetation;
- Problem native fauna (e.g., Corellas, Western Grey Kangaroo) and feral animals (e.g., fox, rabbit) control;
- Weed control (e.g. Paterson's Curse);
- Decline in health of isolated paddock trees.

Some management issues specifically relate to Carnaby's Black-Cockatoo:

- Degradation of unfenced remnant vegetation by grazing;
- The fragmented nature of remnants;
- Plants used in revegetation and how they may benefit or disadvantage Carnaby's Cockatoo;
- Occupation of nesting hollows by competitors such as Corellas and Galahs;
- Nest robbing;
- Deterioration of nesting hollows;
- Landscape position of remnants - most remnant vegetation tends to be located in primary saline drainage lines, valleys or on ridges. There are extensively cleared midslopes, with only isolated paddock trees, across which Carnaby's Cockatoo must move between feeding and nesting sites.

The management practicalities

Two properties, one in the 'East' and one in the 'West' provide interesting examples of the contrast in the kinds of on-ground actions being applied to address landcare issues and which may or may not help Carnaby's Black-Cockatoo.

Property A: 'West' (Perth Basin)

Figure 2: Property A, showing large areas of unfenced remnant vegetation connected by corridors along fencelines. Aerial photography courtesy of the Department of Land Information.

This property has two large areas of unfenced remnant vegetation comprising Banksia low woodland connected by corridors along fencelines. Isolated trees, comprising Prickly Bark *Eucalyptus todtiana,* remain across the paddocks and high quality roadside corridors and extensive bush areas on neighbouring farms adjoin the property. The remnant vegetation is important summer feeding ground for Carnaby's Black-Cockatoo.

The large bush areas are still in comparatively good condition but with some weed encroachment along edges adjoining cleared paddocks. The narrow corridors are still providing food and shelter for Carnaby's Cockatoo but are deteriorating more rapidly than the larger areas because of their susceptibility to degrading 'edge' effects. The isolated paddock trees are in decline but are also still providing food and 'stepping stones' across the landscape for the cockatoos.

The landholders are in the process of fencing one of the areas of remnant and part of a corridor. Revegetation using oil mallees in alley configuration is underway to address wind erosion and generate income through carbon sequestration. The aim eventually is to fence all remnant vegetation occurring in blocks and corridors. The future for the isolated paddock trees is less certain.

Fencing is relatively easy in this terrain with its predominantly sandy soils and long straight sections with few corners. Fencing corners requires 'end assemblies' or, in more simple terms, 'strainers'. In this example, to protect 40 hectares by fencing the remnant and part of the corridor would require five strainers in a fence approximately three kilometres in length.

Property B: 'East' (Yilgarn Craton)

Figure 3: Property B, showing fragmented areas of remnant vegetation largely confined to ridge areas in the landscape. Aerial photography courtesy of the Department of Land Information.

This property has numerous, fragmented areas of remnant vegetation comprising woodland and scrub heath. Vegetation on adjoining properties is fragmented and roadside corridors are narrow and degraded, although still providing nesting habitat for Carnaby's Black-Cockatoo. The property is a breeding area for the cockatoos.

Most of the remnants are confined to the ridge areas in the landscape, with some already fenced from livestock. Vegetation in the valley floor is being affected by salinity. Across the midslope, saline seeps are occurring where bedrock is close to the soil surface.

A combination of measures is being used to tackle the landcare issues. Remnants are being fenced and revegetation using biodiverse and commercial plantings is taking place. SEARCH[2] Project Melaleucas are being planted in saline valley floors, oil mallees along contours in the midslope and biodiverse species on saline seeps and in connecting corridors along creeklines. Ideally, all remnants and revegetation areas should be fenced. However, the size and distribution of the remnants and the rugged terrain on which they occur create difficulties.

To protect approximately 10 hectares, fencing one of the remnants in Figure 3 would require thirteen strainers in a fence approximately 2 kilometres in length. Fencing is difficult in this terrain with its shallow soils over granite or gneiss and irregularly shaped remnants.

Actions for Carnaby's Black-Cockatoo

- On-ground extension is essential to raise awareness of the plight of Carnaby's Cockatoo. This extension may be delivered by various means - for example, Birds Australia's Carnaby's Black-Cockatoo Project, Land For Wildlife, WWF's Woodland Watch Program and the provision of opportunities for landholders to work with scientists researching Carnaby's Cockatoo on private land. Extension may encompass various issues such as remnant vegetation management, advice on species for revegetation, monitoring techniques and funding sources for fencing;
- The 'best' biodiverse plantings on eastern properties may comprise *Eucalypt*, *Melaleuca*, *Hakea*, *Senna* and *Acacia* species. The 'worst' may comprise a single *Eucalypt* species. Work is needed to improve the value of revegetation plantings for Carnaby's Black-Cockatoo, both for the short- and long-term. These plantings would also benefit other fauna, for example honeyeaters, which are important in pollination;
- Sourcing appropriate plants for revegetation that benefits the cockatoos may be difficult. In the case of Grevilleas for example, where many species flower over long periods, cost-effective and efficient seed collection is difficult (Cochrane, 2002). Not all nurseries are prepared to propagate small quantities of seed, and if they are prepared to do so, cost of the seedlings may be prohibitive. More work is required on direct seeding techniques for this region;
- Establishment of artificial nest sites where Carnaby's Cockatoos face competition for nest sites in remnant vegetation from Galahs, Little and Western Corellas;
- Discouraging invasion and occupation of nesting hollows by feral bees;
- Preservation of the genetic resources within remnant vegetation which is under threat from rising watertable and salinity. In the Moore Catchment, 'Rapid Catchment Appraisal' by the Department of Agriculture has identified 25,839 hectares of vegetation out of a total area of vegetation of 333,740 hectares remaining in the catchment as being affected by salinity in the valleys. Future areas of vegetation at risk from shallow watertables are estimated to be 34,440 hectares (Clarke, 2003).

[2] The SEARCH Project is a Department of Agriculture Western Australia initiative subsidising the planting of profitable woody native plant species as perennial plant crops and products suited to the climatic regions and soil types of the Western Australian Wheatbelt – *Ed*.

Conclusion

Landholder values and perceptions will be crucial to the long-term survival of Carnaby's Black-Cockatoo in the northern wheatbelt. For example, to one landholder, an isolated paddock tree might be seen as an impediment to increased agricultural production, and should be removed. The neighbour over the fence might see an isolated paddock tree as having to be preserved for the important ecological functions it contributes to agricultural productivity.

A comment from a 'Land for Wildlifer' describes well what is needed to ensure the survival of the Carnaby's Black Cockatoo – 'We need to work towards a sustainable future by tipping the balance from increasing land degradation to more ecologically sound management'.

Carnaby's on 'Koobabbie'

Alison Doley
Coorow Landholder

John and I farm 'Koobabbie', a 7,173 hectare property in the Waddy Forest district, 250 km north of Perth. The land was selected by my grandparents in 1906. The only early record of black cockatoos came from a great uncle. Whilst staying with my parents my uncle did some shooting and shot a black cockatoo. Fifty years after the event Uncle remembered all too clearly my grandfather's displeasure when he found out (Thorold J. Gregory, pers. comm.).

The clearing was carried out after careful planning and the resulting layout favours Carnaby's Black-Cockatoo. The homestead was sited alongside the east-west road that took the horse transport of the day west across the salt lake system to Coorow. A belt of timber, which varies from 200-400 metres wide, was left on the south side of this road to prevent erosion along a natural drainage line and to provide shelter for the farm buildings.

Included in the timber belt are a number of old salmon gums in which the Carnaby's nest. To feed they must fly west along the timber and across the vegetated salt lake system to the deep yellow sand plain where they can feed on *Banksia prionotes, Banksia attenuata, Hakea priessii, Casuarina obesa* and other native species. They also utilize two exotic species, Wild Radish *Raphanus raphanistrum* and Corkscrew *Erodium spp.* If the farm were being cleared today with the welfare of Carnaby's Cockatoo in mind, the layout would not change much.

Although my family was always interested in conserving the bush and wildlife, no records or diaries were kept. This changed in 1987 when the Coorow Wildlife Study Group invited Denis Saunders to speak on cockatoos. At about the same time an article appeared in *The Countryman* in which Denis asked for interested people to keep a weekly record of bird sightings in a booklet he had prepared[3].

The talk on cockatoos alerted us to the declining range and numbers of the Carnaby's Cockatoo and the checklist ensured that I started to record the arrival and departure and the nesting activities of these birds.

The first birds arrive during the last two weeks of July each year. By the following January they are leaving with only the odd pair remaining until February.

The preferred nesting trees are Salmon Gum *Eucalyptus salmonophloia* with one Gimlet *Eucalyptus salubris* and one York Gum *Eucalyptus loxophleba* the only other species used. Some nests are easily identified where the female is inquisitive or nervous and looks out of the nest each time we pass. In 2002 I recorded 12 nests definitely in use, 5 nests likely to be in use but the contents not examined, and 11 nests not in use. Another visit in Spring 2003 by Ric Dawson and Adam Meyer with their long ladders will increase the list. In 2002 they took DNA samples from six chicks. Three breast feathers from the breast of each chick were removed, the shaft cut off and placed in alcohol. When the exercise is repeated this year it will be possible to determine whether the same birds use the same nest each year with the same partner.

[3] These and similar records of bird sightings from across the Western Australian wheatbelt formed the basis of subsequently published research by Denis Saunders and John Ingram. See D. Saunders & J. Ingram (1995), *Birds of Southwestern Australia: an atlas of changes in distribution and abundance of the wheatbelt fauna*, Surrey Beatty & Sons, Chipping Norton, NSW – *Ed*.

Photo: L. McMahon

Figure 1: Alison Doley and CALM Wildlife Officer Adam Meyer, collecting DNA samples from the feathers of a Carnaby's Black-Cockatoo nestling.

Besides recording nests actual bird numbers have been counted. Each morning at dawn the males, accompanied by females once the chicks are hatched and are old enough to be left on their own, fly to the west to feed. They return mid-morning, fly off to feed early afternoon and return before the sun sets. On 22-11-1994 between 6.20pm and 6.50pm I counted 91 Carnaby's flying home across the salt lake system. If males and females were present and no chicks from the previous year, there could have been 46 nests.

In 2001 the Moore Catchment Group was awarded a community grant from the W.A. Minister for the Environment. Stephen Davies became the co-coordinator for the project. Stephen had carried out research on Carnaby's Black-Cockatoo in the days when they were regarded as a pest species in orchards. On a very small budget he was able to produce much useful information in the report entitled *Carnaby's Cockatoo – Coast to Catchment*. Most of the information in this report is included in Stephen's paper in this volume.

One aspect of research was to determine where the "Koobabbie" birds were feeding and how far they were travelling. In October 2001 Stephen arrived with four students and a two-way radio for each of us. We were stationed at intervals along the Carnaby's anticipated flight path morning and evening. The big surprise was the discovery that the birds were flying 12km west to a neighbour's farm to feed on *Erodium*. Christine Cooper counted 58 birds feeding, of which 55 were males. If no chicks from the previous year were in the flock there could have been up to 55 nests.

Conservation

A number of Carnaby's nest holes are conveniently located along the east-west laneway that runs past the house. In 1995 we observed that the aggressive Western Corellas had moved into four of these nest holes. On the 3rd and 4th of September John and I removed the corella eggs from each nest. Carnaby's Cockatoos returned and bred successfully in two of the nests. In the third they returned and appeared to be nesting. On 16th September two corellas were looking out of

the nest hole. On checking the nest I found two Carnaby's eggs, each with a hole in the side. On September 19th –21st Carnaby's were seen leaving the nest hole. On the 22nd the corellas were back. The nest remained unoccupied for the rest of the year.

By 1997 Neil Johns had commenced employment with us. Neil has a .22 rifle with telescopic sights and soon became interested in the welfare of the Carnaby's Cockatoo. In the course of his work he watches the corellas and when they show interest in a Carnaby's nest hole endeavours to shoot them. This does not appeared to have reduced corella numbers but has stopped them nesting in Carnaby's nest holes. Galahs receive the same treatment.

The trees favoured by the Carnaby's Cockatoo for nesting are very old and suffer from corella and Galah damage, storms, droughts and old age. Since 1970 we have been fencing off remnant vegetation. Of 7,173 hectares we farm 4,270 ha leaving 2,903 ha or 40.5% of the farm fenced off. There are now 64 of these fenced areas of remnant vegetation requiring 59km of fencing. We paid for and erected the first 50km but have received grants for the last 9km. Maintenance of these fences is a constant task as kangaroos crawl under followed by enterprising sheep, and trees fall on the fences.

Since 1987 we have been planting Salmon Gums grown from seed collected on the farm. It will be at least 130 years before these trees are big enough to provide hollows for nesting. Planting among existing mature trees is unsuccessful as the established trees take all the moisture - our average rainfall is 340mm. On favourable sites away from competition Salmon Gums grow well. Stephen Davies measured the spacing between Salmon Gums in mature stands and found a mean spacing of 15.76 metres. As a result he recommended planting Salmon Gums at 20 metre intervals where they are being grown to provide future nest sites.

In the short term, the provision of artificial nest holes appears a viable alternative. This does not mean our dining room chimney where the Carnaby's spent some time in September 1996 chewing off the concrete so that it bounced out on the carpet.

Wally Kerkoff at Moora designed an artificial nest, utilizing metre-long sections of fallen Salmon Gum and Stephen Davies commissioned Wally to construct them. We have seven of these sitting in a shed waiting for John to erect them on poles of four inch galvanized pipe.[4]

A secure food supply is as important to the survival of the cockatoos as nest sites. In 1987 we purchased 2,208 ha to the west of our existing farm and closed up 1,864 ha of salt lake drainage system that had been grazed but not cleared. There is some food for the Carnaby's on this land but the best stands of Banksias are further west. A portion of one stand was burnt when the owner let a stubble fire escape into it. On a neighbour's farm, where the birds were feeding on *Erodium,* there are stands of magnificent Banksias, fenced from stock last year under a Natural Heritage grant. There is also a massive blowout in the yellow sand, approximately 1km long and up to 300m wide, about 10 ha in all. In the years 1997-2000, children from North Beach Primary School grew seed collected at the site and planted them as food for Carnaby's Black-Cockatoo with children from the Coorow Primary School. Sand blasting on the bare site was a problem so old tyres were used to protect the seedlings. The tyres also deterred rabbits. Stephen Davies counted the surviving plants on July 28th 2001 and found 603 growing in the blowout and 276 in the adjoining weedy strip. It was a labour-intensive project but, once mature, these plants, along with the regeneration along the margins with adjoining bush, show that a serious erosion site can be turned into a valuable feeding ground. The complete absence of weeds in the blowout contributed to the success of the planting.

There is now a greater awareness of Carnaby's Black-Cockatoo in the community. A field day organized by Fiona Falconer through Land for Wildlife on July 1st 2002 was well attended. In mid-2003, Leonie McMahon from Birds Australia visited Coorow Primary School with a female Carnaby's Cockatoo, and this was a hit with the children.

[4] A diagram of this artificial nest box is included in Stephen Davies' paper, this volume.

Unfortunately the Coorow Shire Council has not, in the past, demonstrated a conservation ethic. In Spring 2002, in response to an adjoining landholder's verbal request for the McPartland road to be widened for the movement of farm machinery, approximately eleven very healthy Salmon Gums were removed. The cockatoos breed and feed near by and seem to prefer flying along corridors than over open paddocks. The Waddy Forest Land Conservation District and Carnaby's Black-Cockatoo Recovery Team registered their displeasure and on March 20th 2003 a Road Reserves Management Workshop was held. The outcomes of this seminar are now being circulated and in an encouraging accompanying letter the Chief Executive Officer states, 'In the upcoming months council staff will include the outcomes of the Road Reserve Management Workshop in the development of new council policies'.

Conclusion

In 1998 a pair of Carnaby's decided that a truncated York Gum in our house yard would make a suitable nest. On 17th October there was one chick and one egg. In 1999 on 24th October John found eggshell but no chick and a cold egg cracked into small pieces on one side.

By 2000 a hole had developed in the side of the trunk above the floor of the nest and I could climb up on a stepladder and watch progress when the hen had left the nest. The birds have become very used to us and for the past three years we have watched as up to 12 socialize noisily in the tree, as they mate, as the male feeds the female, as the chick grows until during the last week it looks out of the top of the trunk late in the day. As dusk falls it stands on top and exercises its wings. Finally, on December 8th 2002 at 6.00am on a Sunday morning, John saw a youngster take its first flight.

The Carnaby's have become an important part of our lives each Spring, giving us much pleasure and interest as we observe their daily activities.

Cockys for Landcare

John Young and Sarah Mason
Calingiri New Norcia Landcare Conservation District Committee

Carnaby's Cockatoo: a landcare emblem

As the Calingiri New Norcia Landcare Conservation District, we have adopted the Carnaby's Black-Cockatoo as our emblem. We first used the name Cockys for Landcare when applying to become partners in Western Power's Greening Challenge in 2002. I believe that having an endangered bird as our logo and its welfare included in out long term plans was one of the reasons we were successful in convincing the electricity company to come to our area.

We are fortunate in the Shire of Victoria Plains to have about 10% remnant vegetation, some of which is in excellent condition. This enables us to collect seed with local provenance and means there are still good areas for Carnaby's Black-Cockatoo to breed and feed. A lot of understorey species that are used in revegetation projects are ones that benefit the cockatoos - such as Hakea and Grevillea. It's been really useful to have the assistance of Leonie McMahon [Birds Australia WA Carnaby's Cockatoo Project Officer]. We would like to thank Leonie for all her help and encouragement.

We looked at aerial photos of our catchments and saw that the logical way to link the patches of remnant bush was along the creeklines. These need as much vegetation as they can get. It is also easier to convince landowners to replant those areas rather than give up good arable land. By having an endangered species focus it gives us a more tangible target when promoting revegetation. We are trying to save the Carnaby, as well as combat salinity, waterlogging, and weed species.

On the weekend of July 19th 2003 Western Power are bringing up 180 volunteers to plant 40,000 seedlings. There are three groups of 30 school children from years 7and 8, which I feel is really important, as it is showing them a bit of life in the country, and hopefully teaches them some practical aspects of environmental issues. It's important to have these country-city links and links with industry.

Western Power has paid for the seedlings to be grown in Wongan Hills from local provenance seed. There is a strong emphasis on understorey plants, many of which will feed future generations of Carnaby's Cockatoo. The plantings will be spread over 7 sites mostly around Calingiri, which are all close to possible breeding areas of the Cockatoos. We hope the plantings will make the raising of Carnaby Cockatoo chicks more viable.

Through the Men of the Trees, and with advice from Birds Australia, the Million Trees project will be planting 18,000 seedlings in areas around Yerecoin. These are slightly different species to the other sites due to soil type, however all are chosen as Cocky food with some future nesting trees in the mix.

There is some uncertainty about the Greening Challenge after the privatization of Western Power. However we are hopeful that we will be continuing the partnership for a few years. As

stated previously, our long term plan is to link with corridors all the large areas of remnant bush. Using the creeklines we would like to eventually link the Rica Erickson Reserve and Bindoon Army Reserve with the Wyening Mission bushland and the large woodlands around New Norcia. We are always encouraging landowners to protect their remnants. Having the Carnaby as our emblem we can give people a visible reason to look after their bush. Already some former students of Yerecoin Primary School, who were involved in the study of Carnaby's Cockatoo in the school yard, are back on the family farm. One such young man has influenced his father to fence off an area of heath and is planting some more. We want to promote holistic landcare with Carnaby's Black-Cockatoo as our primary goal.

Landcare Drive

Along with many other rural communities we realise that tourism is a potential off-farm income. However we need to have something for people to visit. Our Shire and Landcare District has lots of interesting things, they are just a bit spread out and not well-known. We wanted to showcase what is being done to look after the land and so we developed the Landcare Drive.

The Landcare Drive will take visitors past points of interest some of which have signs like the one we have here. A map and leaflets will be available at towns along the Great Northern Highway. This will bring people off the main road and into our area. The drive will also give information about the history of the Shire and some background information on farming. We hope people will visit in different seasons. The map below shows the locations of some of these places in the area.

Figure 1: map showing the area covered by the Shire of Victoria Plains, and the location of Wyening Mission Farm.

At some stage in the future there will be an interactive information station to show what happens at different times of the year. We hope to stimulate people and get them thinking. We plan to extend the route to other bits of the Shire as it is a diverse landscape. We want the experience to be enjoyable, to inform people, educate them, and showcase the Shire off to its best. Farmers get a lot of bad press and we hope to counteract some of this.

Future Directions: Key Points from the Carnaby's Black-Cockatoo Conservation Symposium

John Blyth[1] and Denis Saunders[2]

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Future Directions: Key points from the Symposium

The following issues were noted by Dr Denis Saunders, the Symposium's keynote speaker, during the day's proceedings, and discussed during the final session.

Dr Saunders made two preliminary points, as follows.

Firstly, the recovery of Carnaby's Black-Cockatoo requires a whole of landscape approach. Such landscape-scale conservation is necessary to provide:

- All of the needs of breeding birds and their offspring in breeding areas, including sufficient food for survival and fledging, and appropriate areas for the 'upbringing' and social learning and development of young birds;
- Sites containing adequate food resources in non-breeding areas to which the cockatoos migrate in the non-breeding season, and probably, more or less continuous vegetation to provide flight paths for the migratory movements of the birds. These resources may also be important for young birds who remain in these non-breeding areas during the breeding season, when breeding birds return to their nesting areas.

Secondly, the Recovery Team and others involved in the recovery of Carnaby's Black-Cockatoo do not need to 're-invent the wheel'. Much information already exists in the literature and an important task is to extract that information which is useful for land managers and make it available to them in a form that is easily accessible.

Future Directions: Key points from the Symposium - the direction of future work and research

1. Relatively little information is available for the southern population of Carnaby's Black-Cockatoo in relation to its status or trends of particular breeding sub-populations. It is important to try to clarify these because the southern population is almost certainly subject to the same threatening processes, particularly loss of vegetation and fragmentation, as the well-studied northern population. The southern population may have a different dialect, and this may help define movement patterns.

2. As noted in the preliminary point about the need for whole of landscape management, suitable breeding and non-breeding areas have to be available for the birds. For example, the value of ensuring sufficient feeding areas close to breeding sites could be lost if the areas to which the birds migrate after breeding have inadequate food resources. This has considerable implications for the management of Gnangara Park during and after the proposed removal of the bulk of the pine plantations during the next 20 years. Urban areas on the Swan Coastal Plain provide important non-breeding habitat and this needs to be drawn to the attention of urban planners and residents. One useful strategy to engage country and urban dwellers in conservation of Carnaby's Black-Cockatoo may be the 'twinning' of urban and rural councils, so that activities for the birds in their breeding areas can be matched with activities in the sites to which they migrate outside the breeding season. 'Cocky friendly' gardens could be promoted by appropriate metropolitan councils.

3. There is a continuing need to assemble and provide to local landowners and community groups information on appropriate local species to replant to provide food plants and, in the longer term, a continuation of nest sites. Such information needs to include species lists, spacing at which to plant the various kinds of plants, and proportions of those various kinds that should be included in plantings. It may be possible to relate such recommendations to soil types and what is known about the original vegetation. Improvement in the quality of such information will be hastened if the methods and results of all such plantings are monitored and recorded.

4. While it is known that some Carnaby's Cockatoos take some invertebrate food during the breeding season, the importance of this is unclear. It would be useful to determine what proportion of diet during breeding is made up of invertebrates, and how significant it is in ensuring the successful raising of chicks.

5. Competition for nest hollows, especially from Galahs, Little and Western Corellas, and feral honeybees, is an important threat to the Carnaby's Black-Cockatoo in the highly reduced areas available for breeding. Targeted control of competing species will remain an important contribution to the breeding success of Carnaby's Cockatoo. Clarification of the significance to the Cockatoo of feral bees and the development of control methods should be given high priority.

6. The continuation and expansion of appropriate revegetation of agricultural areas is a major priority, and ways of initiating and funding the massive plantings needed are still unclear. Several suggestions were discussed, including linking revegetation with requirements for carbon credits.

7. The clarification of the importance to Carnaby's Black-Cockatoo of the species of isolated trees within farming paddocks would be useful. This could come from systematic observation of the movements of breeding birds and from examination of historical aerial photos over time to show decline of these trees. Student projects could be useful in gathering some of the information needed. An element of such studies could be to clarify the significance of Carnaby's Black-Cockatoos to the control of borers, and hence to improved survival of isolated trees that seem to be particularly vulnerable to borer attack.

8. With significant movement of Carnaby's Black-Cockatoos to coastal areas, urban and semi-urban areas - especially those supporting pine trees or remnant vegetation -are now very important to the species. Whether or not the increased number of the species using the coastal areas is simply a result of concentration, following the loss of traditional wheatbelt habitat, needs to be clarified. To do this it is important to establish the age structure of the current population.

9. A suitable baseline for the age-structure studies referred to above already exists within the population at Coomallo Creek studied previously by Denis Saunders. Many of the current breeding adults should be from that area and banded. These known aged birds provide the opportunity to carry out a range of demographic studies.

Carnaby's Black-Cockatoo Recovery Project: Update, June 2005

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In the time that has elapsed since the Carnaby's Cockatoo Symposium, there have been significant developments and changes in the Recovery Project undertaken by Birds Australia WA and overseen by the Carnaby's Black-Cockatoo Recovery Team. In addition, members of the Recovery Team are in the process of instituting a number of research initiatives. A number of the issues raised at the Symposium are either in the process of being addressed or plans are underway to address them. Underpinning most research- or recovery-oriented issues is the ever-present need to secure funding in a constantly changing funding environment.

In recent years there has been a move away from single species conservation and a resulting challenge to impress on funding bodies the wide-spread benefits of recovering a species such as Carnaby's Black-Cockatoo. In its breeding range, the two habitat types critical to its survival, eucalypt woodland and Kwongan heath, are in themselves habitats of significant ecological value. They form the basis of entire ecosystems unique to Western Australia and, unfortunately, are now often under-represented in the landscape and threatened by processes that continue to degrade them.

Clearly we see the value in conserving Carnaby's Cockatoo in its own right but its value as an iconic species, one in whose name recovery work can be carried out with wider benefits, can also allow other conservation targets to be met.

The semi-migratory nature of Carnaby's Black-Cockatoo means recovery work for any given sub-population needs to take place across a number of regions, political boundaries such as shires, and landscape types, for example from the rural communities of the wheatbelt to the highly urbanised Swan Coastal Plain. Threats to critical habitat may be different across the regions, involving a different range of stakeholders and requiring varying strategies to implement recovery actions.

In the period since the Symposium was held, the mechanisms for obtaining Australian Government funding for recovery work have changed. Under a process of strategic regionalisation, all project proposals must now be submitted through one or more of the Natural Resource Management groups, of which there are five relevant to Carnaby's Black Cockatoo. These are the Swan, Avon, South West, South Coast and Northern Agricultural regions.

With the above factors in mind, one of our main objectives in the period since the Symposium has been to secure longer term funding to continue the project. We are on the way to achieving this. The Carnaby's Black-Cockatoo Recovery Project managed by Birds Australia WA, received Australian Government funding through the NHT2 Cross Regional Funding Program for a period of three years (October 2004 to October 2007). This funding could not have been procured without the support of the Natural Resource Management groups, who were at that time endeavouring to complete regional strategies to meet Australian Government and Western Australian Government accreditation. The Northern Agricultural Catchment Council (NACC) accepted the role of lead proponent for the proposal and South West Catchment Council (SWCC) and South Coast Regional Initiative Planning Team (SCRIPT) provided support. It is hoped that the remaining two regions that are relevant to Carnaby's Black-Cockatoo, Avon and Swan Catchment Councils, will be involved in recovery work for the species in the future.

The focus for Birds Australia WA and the Recovery Team is now directed towards obtaining funding in particular regions for on-ground work such as revegetation and protection of critical

feeding and nesting habitat in breeding areas, together with survey work in some parts of the bird's range, and the employment of staff in the individual regions. To this end we will continue to work with the regions, other stakeholders and potential funding bodies. To date, South West Catchment Council has granted funding for a project proposed by the Katanning Landcare Centre that focuses on on-ground work between Katanning and Nyabing.

A particular aspect of critical habitat revegetation work that needs to be addressed is the cost and availability of some plant species used by Carnaby's Black-Cockatoo. While some species, particularly Wandoo *Eucalyptus wandoo* and Salmon Gum *E. salmonophloia* used for nesting hollows, are readily available to farmers and regularly grown, most of the proteaceous and other hard-fruited species utilised as food sources by Carnaby's Black-Cockatoo are not typically included in a Landcare planting mix. The difficulty, and associated higher costs, of producing seedlings of *Dryandra* and *Grevillea* species in particular make them prohibitively expensive for many farmers. Methods of reducing the cost and therefore encouraging the inclusion of more proteaceous species in farm plantings are currently being investigated.

While funding issues have required considerable attention by Birds Australia, other members of the Recovery Team have been directing their efforts towards ensuring further research is carried out which will ultimately inform the direction and focus of recovery for the cockatoo. Research that follows Denis Saunders' early CSIRO work will encompass a range of additional aspects of breeding ecology. Other planned studies include research on the size and distribution of the Carnaby's Black-Cockatoo population on the Swan Coastal Plain and how the species uses the landscape and its resources, including the Gnangara pine plantations. In addition, feral bees have long been serious competitors for hollows and the Recovery Team is investigating methods of control and management used in other areas and their applicability to Western Australia.

Discussion of ways to increase nesting hollow availability has given rise to two separate trials investigating the use by Carnaby's Cockatoo of artificial nesting hollows. Recovery team members have been involved in the trials by the WA Museum and the Million Trees Program. A protocol regarding the use of artificial hollows for this species is now being written. A hollow repair program has been conducted in 2004 and 2005 by Birds Australia WA volunteers at key sites in the Northern Wheatbelt, the early results of which indicate that this may be a time-, resource- and cost-effective method of increasing the breeding potential of Carnaby's Black-Cockatoo.

Recently, CALM has convened a recovery team and written a recovery plan for Western Australia's two other threatened black cockatoo species, Baudin's Black-Cockatoo *Calyptorhynchus baudinii* and the Forest Red-tailed Black-Cockatoo *C. banksii naso*, listed as Endangered and Vulnerable respectively. The Forest Black-Cockatoo and Carnaby's Black Cockatoo Recovery Teams have rather different emphases, but considerable cooperation and mutual benefits will accrue to each team from their different approaches and outcomes.

The Symposium drew together a large number of people including farmers, shire representatives, conservation professionals, researchers, non-government organizations, university representatives, corporations and members of the public. The linkages established have been important in the continuing successful implementation of the Carnaby's Black Cockatoo Recovery Plan.

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