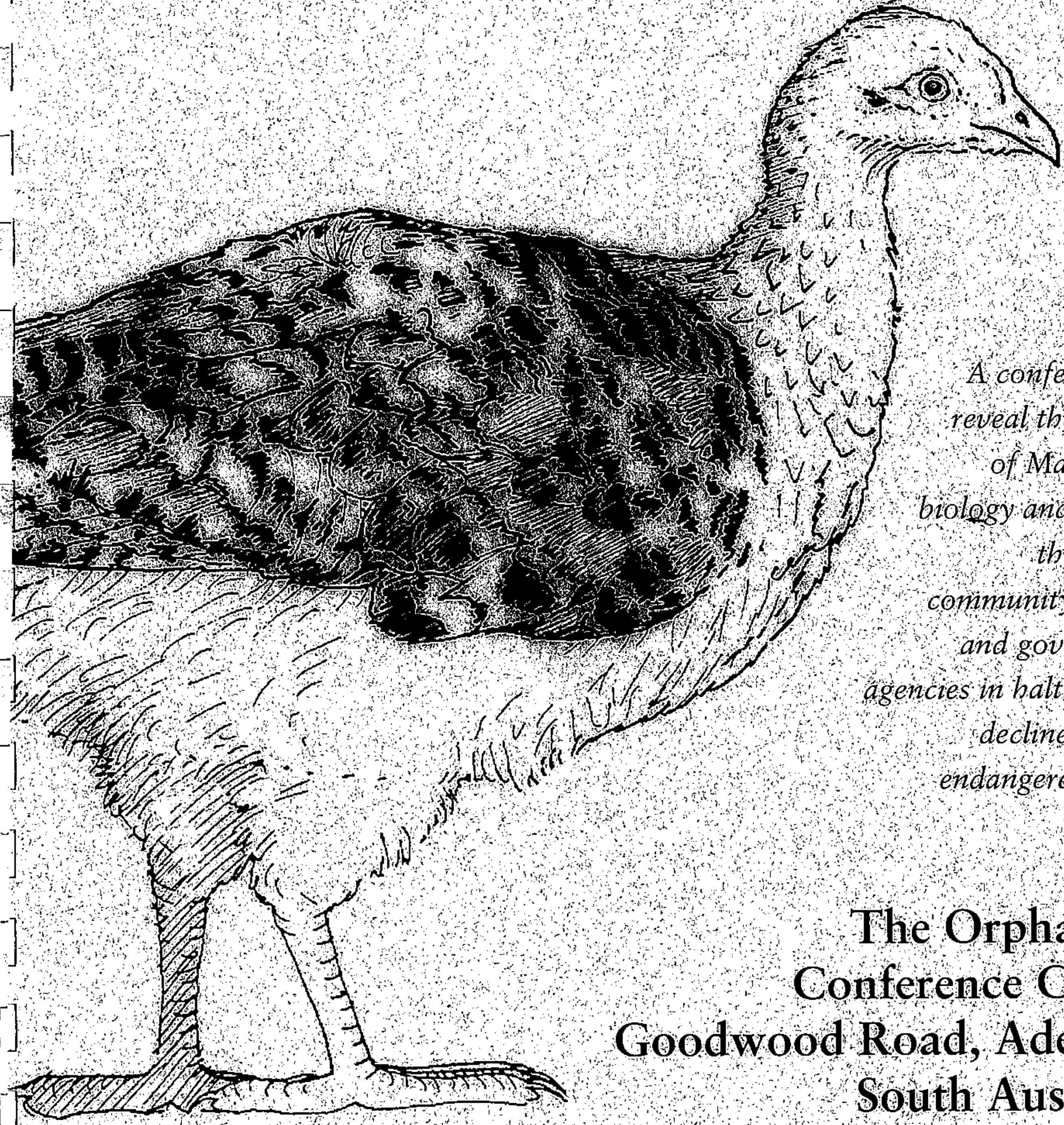
National Malleefowl Forum Handbook



A conference to reveal the secrets of Malleefowl biology and discuss the role of community groups and government agencies in halting their decline toward endangered status

The Orphanage Conference Centre
Goodwood Road, Adelaide
South Australia

16 – 17 September, 1995

Working Papers of the National Malleefowl Forum

Adelaide, South Australia
September 16 – 17, 1995

Organising Committee

Mr. Peter Copley
SA Department of Environment & Natural Resources
Member, National Malleefowl Recovery Team

Dr. Stephanie Williams
Chicago Zoological Society
SA Murraylands Malleefowl Projects Coordinator
Member, National Malleefowl Recovery Team

Ms. Vicki-Jo Russell
SA Coordinator, Threatened Species Network

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Malleefowl Forum Coordinator
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Sponsors

The Chicago Board of Trade through the Chicago Zoological Society

Endangered Species Program, Australian Nature Conservation Agency

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National Malleefowl Forum Program

Saturday 16 September 1995

08:30 Registration, tea and coffee

Session 1

Chair: Peter Copley

09:30 **Welcome and Introduction to the Objectives of the Forum**
Peter Copley
Department of Environment & Natural Resources

Official Opening
Mr. Dennis Mutton, Chief Executive,
Department of Environment & Natural Resources

09:45 **Malleefowl research, management and conservation in Victoria**
Joe Benshemesh
Consultant to the Department of Conservation & Natural Resources
(Joe will speak to the Flora and Fauna Guarantee Action Statement on Malleefowl - a copy of the statement is included in this handbook)

10:35 Morning Tea *(to be served in the conference room)*

Session 2

Chair: John Blyth

11:15 **Distribution, Relative Abundance and Conservation of the Malleefowl in South Australia**
Peter Copley & Stephanie Williams
Department of Environment & Natural Resources
(Peter will summarise the work presented in the unpublished paper which is included in full in this handbook)

11:30 **Mitigation of the threats to the survival of Malleefowl and procedures to maximise the success of reintroductions**
Robert Wheeler & David Priddel
NSW National Parks & Wildlife Service

12:15 **Malleefowl at Eyre Bird Observatory**
Rod Smith
RAOU Eyre Bird Observatory

12:30 Lunch *(to be served in the Refectory)*

Session 3

Chair: Vicki-Jo Russell

13:30 **The value of community input to malleefowl conservation in WA**
Susanne Dennings
Malleefowl Preservation Society, WA

14:00 **Management of Malleefowl on Army Lands in South Australia**
Lawrie Bruggeman
Defence Centre Adelaide

14:10 **Malleefowl Preservation – A Farmer Initiative**
Henry Short
Mantung-Maggea Land Management Group

14:25 **Community Malleefowl Conservation in Victoria**
Archie Vann
Malleefowl Preservation Society, Victoria

14:40 **Conservation and Evolutionary Genetics of the Malleefowl**
Stephen Donnellan & Ralph Foster
Evolutionary Biology Unit, South Australian Museum

15:00 Afternoon Tea *(to be served in the conference room)*

Session 4

Chair: Penny Hussey

15:30 **Forum Discussions**
Break into groups to discuss:

- future priorities for malleefowl conservation projects
- the best options for implementing the projects, and
- the roles a national and/or state "Friends of Malleefowl" network(s) could play in achieving the projects

16:30 Reconvene for reporting, summing up and resolutions

16:55 **Closing remarks**
Ian Sluiter
Consultant to the Department of Conservation & Natural Resources
Chair of Malleefowl Recovery Team

17:00 Pre-dinner drinks in the tennis court rockery (adjacent to the car park)
All forum participants are invited

18:00 BBQ Dinner

20:30 Close of Forum

Papers & Abstracts

CITATION

These papers contain unpublished accounts of research and management activities.

With the exception of the Victorian Flora and Fauna Guarantee Action Statement on Malleefowl, these papers should not be cited without the permission of the author(s) concerned.

In such cases the reference should be cited as a personal communication.

FLORA & FAUNA GUARANTEE

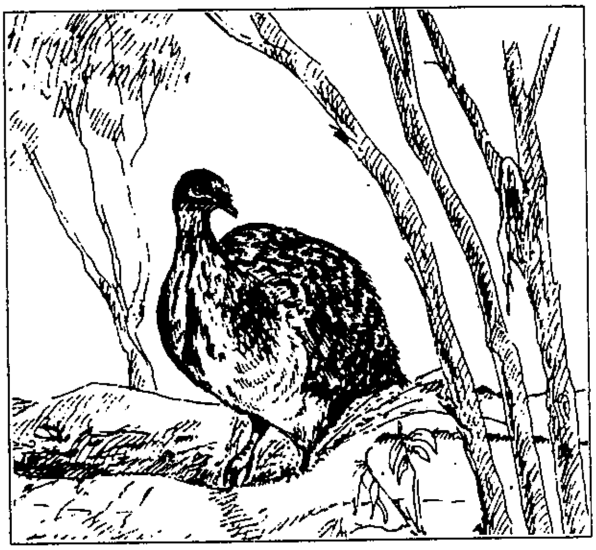
"To guarantee that all taxa of flora and fauna and ecological communities in Victoria can survive, flourish and retain their potential for evolutionary development in the wild."

Malleefowl

Leipoa ocellata

Preamble

This Action Statement forms a key step in the Flora and Fauna Guarantee program. It follows the listing of the Malleefowl under the *Flora and Fauna Guarantee Act* 1988 and outlines the actions to be taken to ensure the long term survival of the species.



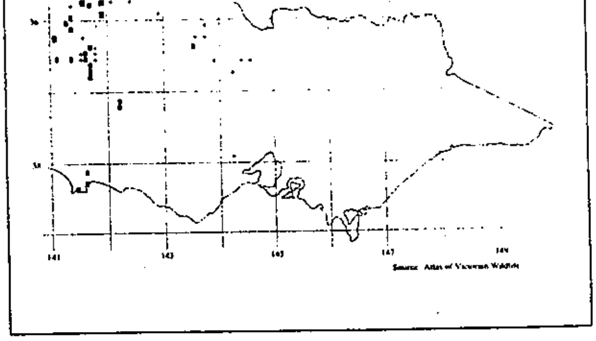
Malleefowl (*Leipoa ocellata*)
Illustration by John Las Gourgues

Description and Distribution

Malleefowl are medium-size (about 1.7 kg), fowl-like birds belonging to the family of megapodes, or mound-builders. The megapodes are unique amongst birds in that their eggs are buried and incubated by external sources of heat (i.e. heat from the sun, geothermal activity, or decomposing leaf litter). The group is mostly confined to moist, warm forests of the Australasian region where such external sources of heat are readily available. Malleefowl differ from all other extant megapodes in that they are largely confined to the semi-arid and arid regions of southern Australia, and have evolved the most sophisticated method of mound construction and incubation of all megapodes (Frith 1956a, 1962b).

Malleefowl are ground-living birds that roost in trees, otherwise rarely flying unless disturbed. They are generalist feeders, eating mostly herbs during the winter and spring (Frith 1962a, Benshemesh 1992a), and seeds and invertebrates during the summer and autumn (Frith 1962a, Booth 1986, Brickhill 1987b).

Malleefowl show little sexual dimorphism and are usually monogamous (but see Weathers *et al.* 1990), probably pairing for life (Frith 1959). Construction and maintenance of the incubator-mound occupies the birds for 9–11 months per year. Mounds are usually about 4 m in diameter and up to 1 m high.



Distribution

Egg laying usually starts in September when the internal temperature of the mound is suitable for incubation. Eggs are laid at 5–7 day intervals until January in most years, although laying may continue into March in unusually mild seasons (Frith 1959). About 15–20 eggs are usually laid per nest with hatching success typically as high as 80% (Booth 1987a, Benshemesh 1992a) unless mounds become saturated (Brickhill 1986) or are raided by Red Fox *Vulpes vulpes* (Frith 1962b). Chicks dig themselves out of the mound and are amongst the most precocial birds known; they receive no parental care, can run swiftly almost immediately after emergence from the mound and fly within a day (Frith 1959, 1962b).

Malleefowl are found predominantly in mallee eucalypt shrublands, but also occur, or once occurred, in a range of other shrubland communities on sandy soils (see Garnett 1992a). Breeding densities are highest in habitat that has not been burnt for at least 40 years (Woinarski 1989, Benshemesh 1990, 1992a), with breeding rarely occurring in habitats that have been burnt within 15 years (Tarr 1965, Cowley *et al.* 1969).

The historical distribution of the Malleefowl covered much of the southern half of the continent from the west coast to the Great Dividing Range in the east (Blakers *et al.* 1984). The species was known from numerous localities in the Northern Territory as far north as the Tanami Desert (Kimber 1985) and appears to have been widespread in every mainland state except Queensland. In Victoria, the species was widespread in mallee shrublands in the north-west of the state, in central Victoria, and as far south as the Brisbane Ranges and Melton near Melbourne (Campbell 1884, 1901, Mattingley 1908).

Within the past century, Malleefowl have undergone a marked reduction in their range. The species has declined in every state in which they previously occurred (Blakers *et al.* 1984) and are believed to be extinct in the Northern Territory (Blakers *et al.* 1984, Kimber 1985). In Victoria, Malleefowl are now largely restricted to remnants of their habitat in the north-west of the state, although an isolated (and declining) population exists at the Wychitella Flora and Fauna Reserve in central Victoria (Gell 1985, Benshemesh 1989). The species no longer occurs south or east of Wychitella.

Conservation Status

Current status

Endangered Species Protection Act 1992 national listing Endangered
CNR (1993) Victorian listing Vulnerable
SAC (1991) Threatened

The Malleefowl has been listed as a threatened taxon on Schedule 2 of the *Flora and Fauna Guarantee Act* 1988.

Reasons for conservation status

Clearing of mallee habitats for agriculture has been largely responsible for the decline of Malleefowl (Frith 1962a), and many populations are now confined to isolated remnants of habitat (Gell 1985, Brickhill 1987b, Korn 1989, Benshemesh 1989, Saunders & Curry 1990, Brandle 1991). Large reserves, where they exist, are mostly in low rainfall areas and on poor soils that are unsuitable for agriculture (LCC 1987); they usually contain low densities of Malleefowl.

The introduced Red Fox is known to prey on all stages of the life cycle of Malleefowl, and is considered the major threat to the conservation of the species in NSW (Priddel 1989).

The extent and frequency of fires pose a serious threat to the conservation of Malleefowl as remaining populations may be destroyed and habitat quality reduced for 40 years or more (Woinarski 1989, Benshemesh 1990, 1992a). The effect of fire is exacerbated by the fragmentation due to clearing, as isolated reserves that are entirely burnt are unlikely to be recolonised.

In NSW the remaining population of Malleefowl has been estimated at 750 pairs (Brickhill 1987b). There have been no detailed estimates of the total Victorian population, although it may be less than 1000 pairs (LCC 1987).

In its final recommendations, the Scientific Advisory Committee (1991) determined that the Malleefowl is:

- in a demonstrable state of decline that is likely to result in extinction; and
- significantly prone to future threats which are likely to result in extinction.

Major Conservation Objective

The major conservation objective is to increase the Malleefowl breeding population in Victoria to 2000 pairs over the next 20 years.

Management Issues

Ecological issues specific to taxon

Habitat quality for Malleefowl is severely reduced by fire (Tarr 1965, Cowley *et al.* 1969, Woinarski 1989, Benshemesh 1990, 1992a) and more effective fire control may be the single most important factor in improving the conservation status of the species. Conservation reserves should ideally be large enough to allow for large scale disturbance such as fire (Pickett &Thompson 1978), but the scale of fire in mallee landscapes is similar to the size of even the largest mallee reserves. For example, within the Big Desert landsystem, which is the major stronghold of Malleefowl in Victoria (Emison *et al.* 1987), extensive wildfires have occurred with a frequency of about once every 20 years (Cheal *et al.* 1979, Day 1982), the most severe of which burnt about 600 000 hectares (Cheal *et al.* 1979).

In general, the LCC (1987) has estimated that over 60% of Victorian mallee has been burnt during the past 15 years. Similarly in New South Wales, mallee that has remained unburnt for more than 20 years is rare, the majority having been burnt in a series of wildfires that covered about 1.5 million hectares of this habitat type in the summer of 1974/5 (Noble *et al.* 1980, Noble 1984).

While the negative effects of fire on Malleefowl breeding densities are severe and long-lasting, other aspects of Malleefowl ecology may mitigate these effects, provided that fires are not extensive, and that long-unburnt patches of habitat frequently occur. Benshemesh (1990, 1992a) found that breeding Malleefowl confined to small unburnt patches in otherwise recently burnt mallee readily fed in the burnt areas, and their breeding success was similar to that before the fire. Moreover, newly hatched chicks dispersed widely (up to 5 or 10 km) through the burnt areas and were able to survive in these areas for several weeks at least. Thus, fires with a high edge-to-area ratio, such as fire-breaks, are likely to do less harm to Malleefowl populations than fires of the same size but with less edge. Mosaics of habitat at various ages might also provide a balance between habitat requirements of Malleefowl and protection from fire, and the attributes of such beneficial mosaics should be investigated after the populations of the birds are mapped across the larger reserves..

Malleefowl densities are known to be severely reduced in areas grazed by sheep, and a similar effect is likely where other feral or native grazers are over-abundant. Frith (1962a) reported that habitats grazed by sheep supported only 9–16% the density of breeding pairs that were supported by ungrazed habitat, an effect probably due to competition for food supplies and because continual sheep grazing prevents the regeneration of many herbs and seed bearing shrubs. Licensed grazing on most public land in Victorian mallee is due to be phased out during the next decade (LCC 1989). However, the feral Goat is common in some mallee areas (Henzell & McLeod 1984, Newsome 1989), may be more damaging to shrub populations than sheep (Harrington 1979, 1986), and need to be controlled. Over-abundance of the Western Grey Kangaroo at some Victorian reserves (e.g. Hattah–Kulkyne National Park) may produce similar detrimental effects as sheep grazing. Rabbits are generally rare in mallee (Frith 1962a) except at the mallee edge, but might have a severe effect in small reserves with a high edge-to-size ratio.

Foxes have long been considered a serious threat to the conservation of Malleefowl, and are currently regarded as the major factor contributing to the decline of Malleefowl in New South Wales (Priddel 1989, 1990). High predation rates by Foxes on eggs has been recorded (Frith 1959, 1962a) although more recent studies have recorded negligible levels (Booth 1987, Brickhill 1987b, Benshemesh 1988, 1992a) suggesting that significant predation on eggs is uncommon. Foxes are known to take adult birds, but most studies have shown only low levels of predation on adults (Frith 1962a, Benshemesh 1988).

Chick mortality due to Foxes (and perhaps feral Cats *Felis catus*) can be high. In Victoria, about a third of deaths of radio-tracked chicks were due to Foxes (and possibly Cats) (Benshemesh 1988, 1992a), and similar studies in New South Wales have found that 40–60% of chicks were taken by Foxes (Priddel 1990). Both studies reported severe (about 80%) mortality during the first two weeks after release, and in neither study were any chicks known to survive more than a few months; other major causes of deaths being predation by raptors, and metabolic stress (probably starvation). Nevertheless, very high mortality (around 98%) is expected at some stage of the life cycle of Malleefowl as adults are long-lived in the wild and are likely to produce 100–200 young in their lifetime (Frith 1962a,b, Benshemesh 1992a).

Definite statements about the stability of populations in undisturbed habitat are difficult to make because of the paucity of long-term data on population levels at specific sites. Recent work suggests that Malleefowl populations are stable in the north-west of the state at sites that have not been burnt for several decades (Benshemesh 1989, 1992a). However, recent declines have been evident in smaller reserves at the edge of the species current distribution in Victoria (Gell 1985, Benshemesh 1989), and Fox predation may be a critical factor at these sites. In general, the effect of Fox predation on Malleefowl populations is probably related to the size of the habitat patch and the quality of that habitat for Malleefowl. Fox densities are considerably higher in areas close to agricultural land (Benshemesh 1992a) and are more likely to depress Malleefowl populations in marginal habitats where the species' hold may already be tenuous.

Whilst the status of the Malleefowl in Victoria is vulnerable, their ecology and distribution provide several advantages toward conservation of the species. These include their wide distribution both within the State where most suitable habitat is now reserved and can be managed appropriately, and interstate. Long-term stability of populations is facilitated by the high fecundity and longevity of adults, and restocking areas in which the species is declining is simplified by the readiness of the birds to breed in captivity, the lack of parental care of young, and the ease of rearing chicks.

Wider conservation implications

A reduction in the extent and frequency of fires in Malleefowl habitat is likely to benefit several species of wildlife whose future is insecure, and disadvantage none. Six other species of birds that inhabit Victoria mallee are considered endangered or vulnerable, and all prefer long-unburnt mallee (Meredith 1984, Emison *et al.* 1987, Garnett 1992a). Similarly, several species of threatened reptiles require long-unburnt mallee, while none requires frequent fire (Robertson *et al.* 1989). The control of feral mammals such as Goats, Rabbits and Foxes in Malleefowl habitats is likely to benefit both the flora and fauna of the mallee ecosystem. However, Rabbits and Foxes may need to be controlled in unison. This might be accomplished by poisoning Rabbits with 1080, thereby also poisoning Foxes that feed upon them (McIlroy & Gifford 1991). Fox predation on native fauna might temporarily increase if only Rabbits were reduced.

Social and economic issues

Most, if not all, significant populations of Malleefowl occur within conservation reserves. Hence implementation of this Action Statement should not disadvantage private landholders.

A reduction in the frequency and extent of wildfire would benefit landholders.

Securing the species in Victoria would benefit tourism generally, and the burgeoning ecotourism industry in particular. The Malleefowl has wide popular appeal and is well known internationally for its remarkable nesting habits.

Although Malleefowl are usually shy and elusive, many birds become conditioned to the presence of humans and may be quietly observed working their nesting mound on most days in spring and summer. Small groups of people at close quarters are often tolerated by the birds. The species is a major tourist attraction at Wyperfeld National Park, and for commercial tours operating in the Little Desert, Big Desert and Sunset Country regions.

The Malleefowl also provides a unique educational experience for schools, serving as an important illustration of principles in conservation, ecology and evolution. The Sea Lake High School has been visiting a site in Wathe Flora and Fauna Reserve for over 15 years, with Malleefowl being the focus of the excursions. Wyperfeld and Little Desert National Parks receive numerous visits from local and urban schools, as does the commercially operated Little Desert Lodge near Nhill, which is specially equipped to provide information on Malleefowl biology.

Several community groups have recently formed to assist in the conservation of Malleefowl in Victoria. These include the Malleefowl Preservation Society based in Mildura, and the Friends of the Malleefowl in Nhill. Other natural history clubs have made important contributions to the conservation of Malleefowl, including the Mid-Murray Field Naturalists, the Bendigo Field Naturalists, and the Friends of Wyperfeld.

Previous Management Action

- Several reserves created explicitly for the conservation of Malleefowl after lobbying by local natural history groups are: Wyperfeld National Park, Kiata Lowan Sanctuary, and Wathe, Wandown, and Wychitella Flora and Fauna Reserves.
- Frith (1956a,b, 1957, 1959, 1962a,b) undertook the first major research program on Malleefowl biology, publishing detailed accounts of the birds' breeding biology and conservation. In particular, Frith detailed the effect of grazing on Malleefowl densities, the distribution of the species in New South Wales, Fox predation on eggs and adults, and warned of the species imminent danger of extinction if clearing for agriculture continued and reserves were not created.
- In the early 1960s the Fisheries and Wildlife Division (Victoria) surveyed numerous sites for Malleefowl in north-western Victoria, which led to the acquisition of several reserves, including Wathe and Bronzewing Flora and Fauna Reserves.
- Angus Torpey and family surveyed a portion of Wathe reserve for Malleefowl nests in the early 1960s, and thereafter monitored this population for several years. These records suggest that Malleefowl numbers have not declined substantially over the past 30 years.
- In the early 1960s, the Bird Observers Club of Victoria conducted a search for Malleefowl nests in portions of Hattah National Park (Jones 1963), and several years later the Mid Murray Field Naturalists searched part of Wandown Flora and Fauna Reserve (Haywood 1970).
- Brickhill (1985, 1987a,b) examined the distribution, summer diet and breeding success of Malleefowl in New South Wales and developed methods for aerial surveys of nests. His findings confirmed that the species had declined alarmingly in that State, largely due to the extent of clearing but also due to other undetermined factors.
- Booth (1986, 1987) examined the ecology of Malleefowl in low rainfall mallee in South Australia. He provided data on home-range and breeding success and recorded unusually high predation of adult Malleefowl by Foxes.
- In 1983, the Victorian National Parks Service and National Estate (Victoria) funded a four-year study into the conservation ecology of Malleefowl in that state (Benshemesh 1988, 1990, 1992a). This study examined the cool season diet, ranging behaviour, breeding success, survivorship of chicks, habitat preferences and fire ecology of the species. Various volunteer groups made major contributions to this study, including the Friends of Wyperfeld and Operation Raleigh who established 12 monitoring sites in NW Victoria totalling over 30 km^2.
- In 1984 a major research program on Malleefowl conservation was initiated in New South Wales (Priddel 1989, 1990, Priddel & Wheeler 1990). This work, still under way, has focused on the factors affecting the survivorship of chicks and has demonstrated heavy predation of chicks by Foxes.
- Since 1984, three to four Malleefowl have been kept in captivity at the Little Desert Lodge (Wimpy Reichelt, proprietor) near Nhill. The birds are exhibited to the public and information is provided on the biology and conservation of the species. The Little Desert Lodge also has facilities to incubate Malleefowl eggs, and these are used (under permit) to hatch eggs from abandoned nests, and from nests on isolated remnants where the survival of chicks is unlikely. The resultant chicks are released into suitable reserves.
- In 1988 a major captive breeding program for Malleefowl was established at the Taronga and Western Plains Zoos in collaboration with the NSW National Parks and Wildlife Service with the aim of providing birds for restocking reserves in NSW.
- Following the LCC (1989) final recommendations for the Mallee Region and their acceptance by the Government, most areas in which Malleefowl occur in Victoria were incorporated into conservation reserves.

- In 1989 DCE funded a three month project (Benshemesh 1989) to permanently mark the 12 monitoring sites originally searched by Operation Raleigh (Benshemesh 1988), install and thoroughly search three new grids, and prepare a selection of eight grids for subsequent monitoring.
- Two grids for ongoing monitoring of Malleefowl were established in South Australian mallee late in 1989 (Brandle 1991).
- In 1990 DCE funded a three-month study into the feasibility of thermal-sensing active Malleefowl nests using an airborne infrared scanner (Benshemesh 1991), and to facilitate ongoing monitoring of prepared grids by DCE staff. This study showed that nests opened by the birds were detectable from aircraft, that the technique was potentially an efficient method of surveying vast areas, and that such surveys would be economical. However, further data were clearly needed to assess the overall feasibility of the technique and for its calibration.
- During the 1990/91 season DCE initiated regular monitoring of breeding densities at seven of the grids established by Operation Raleigh. This has been undertaken annually since, and three new grids have been added to the program. Associated with this monitoring are trials on the effect of removing Foxes from selected grids.
- In 1991, DCE staff assisted by members of the Chicago Zoological Society, Malleefowl Preservation Society and the Mildura Bird Observers Club established and searched a monitoring grid in the Murray–Sunset National Park (Sluiter 1991).
- A Fire Protection Plan for public land in the Mallee Region of Victoria was drafted in 1991 (Edgar 1991). Although not aimed specifically at Malleefowl conservation, it describes actions that would benefit Malleefowl in the long term.
- Late in 1991 DCE funded a six-month project to continue assessing the feasibility of thermal-sensing Malleefowl nests (Benshemesh 1992b), and to review the DCE monitoring effort. Although further trials of the thermal-sensing technique were not possible, ground-based data provided guidelines for when to conduct scans, and suggested that more than a third of active nests would be detected by a single scan in spring.
- In 1992 an important private block of habitat ('Menzies') that supports a high breeding density of Malleefowl was bought by DCE with the assistance of the Victorian Conservation Trust and the Mid-Murray Field Naturalist Club
- The Mid-Murray Field Naturalist Club established a fund in 1992 to help in Malleefowl management and the acquisition of Malleefowl habitat on private land.
- Early in 1993 a Recovery Plan Research Phase for Malleefowl was drafted (Benshemesh 1993). This document described research that is urgently needed to conserve Malleefowl in southern Australia, and was funded by ANPWS.
- Late in 1993 a series of trials of the thermal-sensing technique for mapping Malleefowl nests was conducted in preparation for broad-scale surveys. Important information about the abundance of Malleefowl was also collected during the trials.
- Foxes at three Malleefowl populations were controlled by 1080 baiting in 1990. Two of these (covering about 10 km^2) have received continuing control to the present time.
- In 1994 a monthly cyanide-based Fox control program was begun on a 6 km^2 Malleefowl grid to determine the demographic characteristics of Foxes that visit Malleefowl mounds. This is running concurrently with a similarly timed 1080 program and freefeed (control) prgram elsewhere in the Mallee.
- A further five monitoring grids were installed in the Murray–Sunset National Park through 1993, with the aid of the Australian Trust for Conservation volunteers.
- A Mallefowl monitoring grid was established at Hattah–Kulkyne National Park in conjunction with the Malleefowl Preservation Society and Mildura Venturers, making a total of 15 established grids.

Intended Management Action

Monitoring

- Continue CNR's annual monitoring of the eight grids so far prepared.
- Extend the monitoring grid system to incorporate a representative sample of habitat types and landscape contexts in Victorian mallee sites surrounded by suitable habitat and cleared land where ecological pressures may differ). This will involve another 10–12 sites, at least half of which will be selected for annual monitoring and the remainder monitored every 3–5 years.
- Examine the habitat difference between sites at which Malleefowl populations have declined and those which have remained stable or increased.
- Coordinate and liaise between the various natural history groups involved in Malleefowl conservation to ensure that their efforts are directed at critical issues and complement the works undertaken by CNR.

Inventory

- Further refine existing thermal-sensing techniques for rapidly surveying Malleefowl breeding densities. In particular, data on the nest-opening behaviour of Malleefowl will be collected by CNR (Mildura) over the following three years, and further flights will be conducted to fully test and describe the technique.
- Describe and map the critical habitat of the Malleefowl within the larger blocks of mallee in Victoria, and prescribe appropriate management for these (such as fire control works). The thermal-sensing method will be used to survey breeding densities, and the data collected will be used to estimate the total population size for the state.
- In collaboration with ANCA and other state conservation agencies, extend the use of the remote sensing technique to include large blocks of Mallee outside Victoria.

Population Protection
- Continue 1080 control of Foxes on two Mallefowl grids.
- Continue cyanide poisoning of Foxes on one Mallefowl grid until 1996.

Research
- Continue and extend the trials on the effectiveness of Fox control on increasing Malleefowl abundance. No more than half the annually monitored sites will be subject to Fox control, the remaining serving as controls to the trials.
- Intensify Fox control if the ongoing research into the impact of Fox predation on Malleefowl in small reserves indicates the need.
- Examine the habitat preferences of Malleefowl, in particular the effects of timing, frequency and size of wildfires on the species (Garnett 1992b, Benshemesh 1993, Silveira 1993).
- Determine the longevity of breeding Malleefowl, and the rate of recruitment of young birds into the breeding population. This would necessitate a long-term study (10–20 years) of banded or otherwise permanently marked birds. These data are crucial for interpreting the stability of populations and the effects of introduced predators.
- Collect Malleefowl genetic material for the South Australian Museum which is examining the variation in the species across its range. This work will elucidate any major population units and disjunctions for the species across its Australian range. It will assist with management of populations in key small reserves and with any possible reintroductions to areas where the species may be locally extinct or very rare.

General
- Implement the Fire Protection Plan for public land in NW Victoria, and refine this plan when critical Malleefowl habitats are identified and mapped.
- Continue to seek acquisition of small private land blocks with the aid of community groups such as the Mid-Murray Field naturalists and Victorian Conservation Trust.
- Foster the Land for Wildlife scheme with those landholders sympathetic to the concept of Malleefowl conservation.
- Continue to cooperate with individuals and community groups to protect Malleefowl and their habitat.
- Investigate the feasibility of organised community groups assisting with Fox control programs (shooting) in appropriate areas.

Other Desirable Management Action

- Describe the degree to which habitat corridors are used by the birds, and the critical attributes of these that determine that use. Habitat corridors that facilitate dispersal of Malleefowl to neighbouring reserves may be of great benefit to their conservation and reduce the likelihood of local extinction.
- Restock with Malleefowl those reserves in which the species has severely declined or become extinct. This is especially desirable in central Victoria. However, the reasons for these declines should first be elucidated, and appropriate management implemented to improve the suitability of these reserves for Malleefowl.

Legislative Powers Operating

Legislation

Wildlife Act 1975 controls research, management and taking of protected wildlife.
National Parks Act 1975 provides for the reservation and management of natural areas.
Flora and Fauna Guarantee Act 1988 provides for the protection of flora and fauna in Victoria and the declaration of critical habitat.

Licence/Permit Conditions

A permit will not be given unless a proposal conforms with the broad conservation and research strategy proposed in this Action Statement and the ANPWS Recovery Plan.

Consultation and Community Participation

Natural history groups have played a major role in securing unreserved habitat (especially the Mid-Murray Field Naturalists) and assisting in surveys. CNR will continue to encourage this participation.

Implementation, Evaluation and Review

The Area Managers, North West and South West, are responsible for coordinating the implementation of this Action Statement. This document will be reviewed by the Flora and Fauna Branch five years after its publication.

Contacts

Management
CNR Flora and Fauna Guarantee Officers in Mildura, Horsham and Bendigo offices.
Flora and Fauna Branch, CNR.
National Parks Service, CNR.

Biology
J Benshemesh, CNR Mildura office.
Flora and Fauna Branch, CNR.

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Distribution, Relative Abundance and Conservation of the Malleefowl in South Australia

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Summary

Despite considerable research and survey efforts made by the South Australian Department of Environment and Natural Resources, community groups and individuals since 1989, the distribution and status of malleefowl in South Australia has not been thoroughly determined. Local extinctions and declines in abundance appear to have occurred throughout most of their former range in this state. Declines have been due primarily to loss of habitat as a consequence of clearing and the resultant degradation of remnant habitats, particularly of small habitat patches, from rabbit and livestock grazing and the invasion of introduced predators (foxes and cats).

Data on the distribution and status of malleefowl in South Australia have been collected and compiled in various ways including biological survey programs and landowner questionnaires. D.E.N.R. has investigated the impacts of several of the perceived threats to malleefowl, including possible low reproductive success, fox and cat predation, habitat degradation from domestic and introduced herbivores and fire.

An on-going program has been established in Victoria and South Australia in which malleefowl nest mounds are mapped within permanently marked grids. These grids provide our most accurate indications of changes in the numbers of breeding birds in the short and long term throughout the current range of habitats supporting malleefowl populations. If declines are observed, these data can then be used to ascertain which threats are contributing most significantly in which sorts of habitats. The data also provide quantitative assessments of the effectiveness of conservation management programs.

Although the mapping technique has been designated by the National Malleefowl Recovery Team as one of the major research and monitoring priorities for the recovery of the species, state and federal governments do not have the staff resources to conduct these surveys without assistance from volunteer surveyors. The success of the program is, therefore, dependent on the involvement of many other people. In South Australia eleven mapping grids have been at least partially established, largely through the input of dedicated volunteers, but several have lacked the amount of support necessary to conduct the surveys satisfactorily. Many grids have been surveyed only once and many habitats have yet to be included in the program. These additional data are required to highlight geographic variation in breeding densities, reproductive success and relative population status.

Introduction

Serious declines of malleefowl populations in New South Wales and an increased understanding of threatening processes in Victoria led to the development of a series of inter-related research and survey programs by the D.E.N.R. to assess the distribution and status of malleefowl populations in South Australia.

The South Australian Department of Environment and Planning, now Environment and Natural Resources (D.E.N.R.), began studies to determine the status and management requirements of malleefowl within South Australia in 1989. At that time the range of the malleefowl in the state was thought to have contracted considerably, even though it was known to still be widely but patchily distributed. David Booth had recently undertaken a Ph.D. study of the reproductive physiology of malleefowl with a study site on Calperum Station near Renmark (see Booth 1984, 1986, 1987a, 1987b, 1987c and Booth and Seymour 1984). A wide range of recent malleefowl records across southern South Australia had been published in the Royal Australasian Ornithologists Union's *The Atlas of Australian Birds* (Blakers, *et al.* 1984). Many National Parks and Wildlife Service reserves and Heritage Agreement areas were known (or suspected) to support malleefowl. Despite this knowledge, the malleefowl's past and present distributions were poorly documented.

The studies undertaken in South Australia since 1989 were instigated primarily because recent research in New South Wales (Brickhill 1985, 1987a, 1987b; Priddel 1989) had suggested that recruitment of malleefowl chicks into the remaining breeding population was being limited severely through predation, especially by foxes. It was thought that at that time there were only about 750 pairs of malleefowl in New South Wales (a very small percentage of its former abundance) and that this number was continuing to decline. In addition, recent work in Victoria by Benshemesh (1989, 1990) had suggested that the remnant and fragmented malleefowl populations were also at risk of local extinctions through the loss of their preferred mature mallee habitats (older than 25-30 years since last fire) to wildfires. However, Benshemesh's work also suggested that many remnant malleefowl populations in long-unburnt habitats in Victoria occurred at breeding densities suspected to be similar to those at any time in the previous 200 years, suggesting that predation may not be such a serious threat in these areas.

In South Australia, we therefore wanted to know more accurately where malleefowl still occurred, what breeding densities they occurred at within different remnant habitats, and whether they were declining throughout their range, or only in some areas, or not at all. If malleefowl were declining as suspected, we also needed to know which perceived threats were contributing most significantly. This information could then be used to determine how best to target conservation efforts within the state.

As a first step to investigating these questions, three South Australian Department of Environment and Planning staff (Peter Copley, Peter Macrow and Tony Robinson) visited Joe Benshemesh in the field in western Victoria in May 1989 to learn his techniques for establishing a malleefowl population monitoring program by mapping each season's active nest mounds on 250-500 hectare grids permanently fixed within large areas of occupied habitat.

The Department then commenced a malleefowl survey and monitoring program for South Australia from which several conservation projects have arisen. A summary is given below.

Malleefowl Distribution in South Australia

Although various programs have been established to determine the distribution of malleefowl in South Australia, our understanding of their current range is incomplete, particularly in the state's sparsely settled regions.

The distribution of malleefowl in South Australia is being documented in several ways. Records of malleefowl within the National Parks and Wildlife Service reserves system are entered on a *Reserves - Vertebrate Fauna* database. Records for Heritage Agreement areas are maintained by the Native Vegetation Management section of D.E.N.R. These records have been collated for the eastern part of the state by Joanne Cutten, who has also obtained additional location information through a questionnaire sent to landholders in the region (Cutten in press). Most of the information obtained through these sources is area-based, with records referenced to a particular park or habitat remnant rather than to more accurate site locations (or specific habitats) within those areas. D.E.N.R'.s SURVEY database contains more accurate point-based records compiled from systematic regional biological survey work to supplement the location data from these other sources.

To date, available data on the distribution of malleefowl in South Australia have been heavily biased in favour of the eastern part of the state, primarily because this is where most survey effort has been focused. This bias should be rectified over the next few years as biological survey effort is concentrated in the other agricultural areas.

These data show that malleefowl still occur as far south in South Australia as Mt. Scott Conservation Park and adjoining habitat remnants inland from Kingston in the south-east. However, there have also been records of sightings further south in Big Heath Conservation Park within the past 15-20 years and at Fairview Conservation Park within the past five years (Cutten in press). From the upper South-East, malleefowl occur northwards through the Murray Mallee into Bookmark Biosphere Reserve and Pooginook Conservation Park (both on the north side of the River Murray), and are scattered very sparsely through some of the remnant mallee communities to the west of the river from Ferries-McDonald Conservation Park to just north of the Sturt Highway (see Fig. 1).

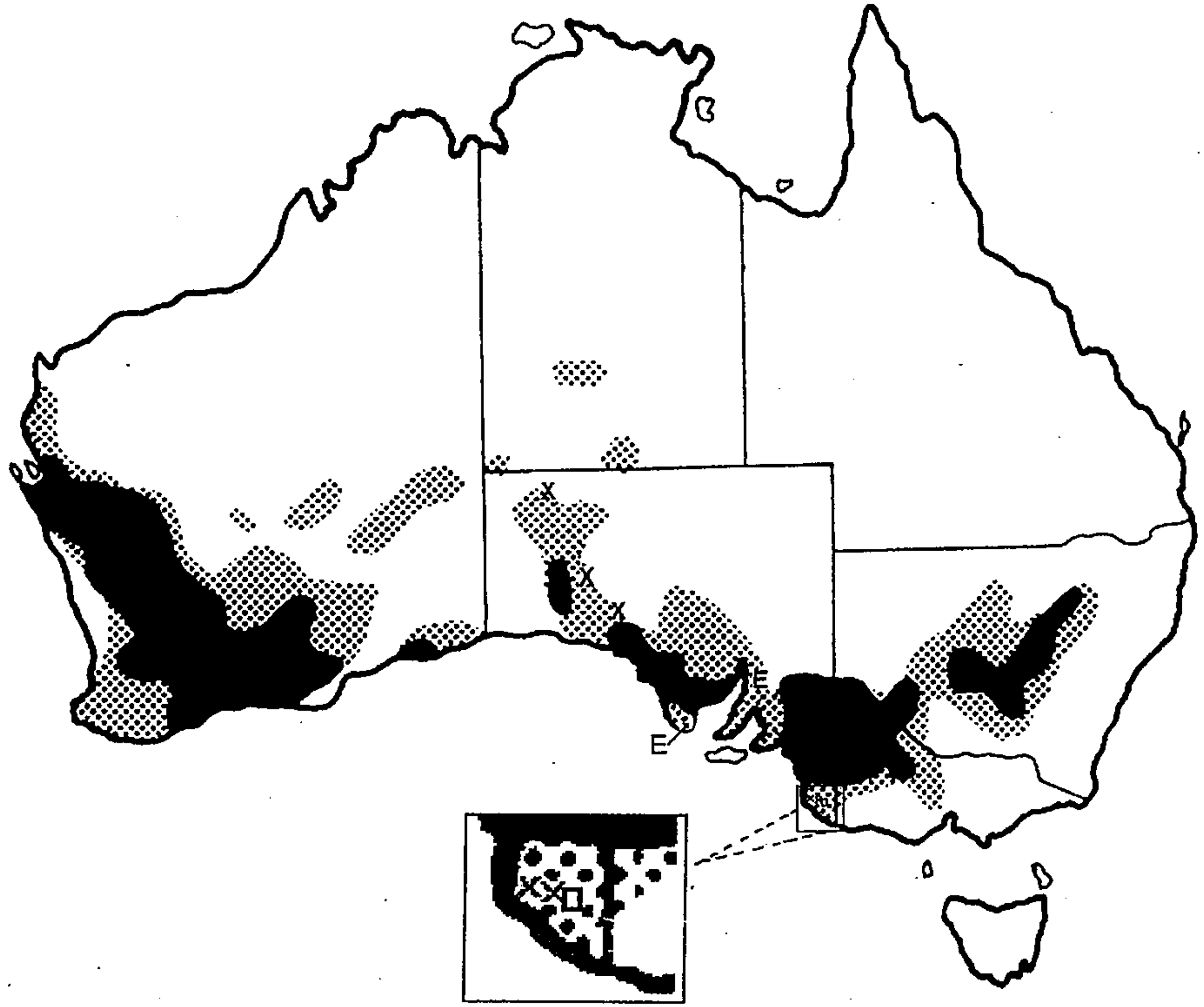

Fig 1.

Distribution of the malleefowl: past and present (solid area, present distribution; stippled area, prior distribution; Source: Priddel 1989)
X = Post 1984 sightings E=Recent local extinctions □= Probable local extinction

To the west of these areas is a hiatus through the northern Mt. Lofty Ranges, Adelaide Plains, Mid-North and northern and central Yorke Peninsula, all districts where malleefowl are now extinct. The nearest surviving populations to those local extinctions occur at Innes National Park and a few adjoining scrub remnants on lower Yorke Peninsula.

There is then another hiatus in distribution across and around Spencer Gulf to the mallee communities on the south and west side of the Middleback Ranges on north-eastern Eyre Peninsula. This gap in distribution, caused by the Flinders Ranges and Spencer Gulf, may have been the only long-standing gap in the malleefowl's otherwise continuous distribution across southern Australia.

From Pt. Augusta malleefowl still occur through the mallee scrubs and heaths westwards around the northern side of the Nullarbor Plain (through the Yellabinna and Great Victoria Desert dunefields and sand plains) into Western Australia. They also occur in many of the larger bush remnants across and down most of Eyre Peninsula. However, one apparently recent extinction has occurred in Lincoln National Park at the southern tip of the peninsula, with no records of malleefowl made there since 1974.

Clearing of the malleefowl's preferred habitats for agriculture has been largely responsible for the decline of the malleefowl across much of its southern range. The once almost continuous population is now divided into numerous populations, including many confined to relatively small and isolated habitat remnants. Within the agricultural districts of South Australia most of the larger remnants with malleefowl present occur within National Parks and Wildlife Service reserves or Heritage Agreement areas. Nevertheless, even these are widely regarded as providing sub-optimal habitat for the malleefowl and contain relatively low densities of malleefowl. Most were left uncleared simply because they are generally unsuitable for agriculture, which makes them similarly unsuitable for malleefowl. Many are in lower rainfall areas that are frequently dominated by poor soils and habitats with low vegetation diversity.

In contrast to these perceptions, a huge proportion of the malleefowl's habitat within South Australia - and a fact often overlooked - occurs in the Great Victoria Desert. These habitats stretch from the western end of the Gawler Ranges, through the Yellabinna region around the northern margins of the Nullarbor Plain into the Western Australian Goldfields and beyond, and north to the Everard and Mann Ranges near the Northern Territory border. Recent records of malleefowl in this desert country, illustrated in Figure 1, have come from just west of Mount Finke in Yellabinna (Robinson, et al. 1990), near Oak Valley (WNW of Maralinga) (Robinson, et al. 1990), and from about 80 km WSW of Fregon in the Anangu Pitjantjatjara Lands (1995, unpublished data).

However, these malleefowl populations may not be secure in the long term. They appear to be very sparsely distributed through these desert environments and, in the last instance mentioned, occupy dense stands of long-unburnt mulga (*Acacia aneura / A. minyera*) shrubland and woodland, plant communities which are highly sensitive to fire and are usually surrounded by fire-induced/fire-tolerant open shrublands and hummock grasslands. Vegetation clearance and habitat fragmentation have not occurred in these areas, yet both the range and abundance of malleefowl are apparently declining. The cause or causes of this decline have not been confirmed, but predation by introduced foxes and/or the widespread effects of wildfires on the malleefowl's preferred habitats are suspected. Whatever the situation, malleefowl in this region have probably 'always' had a very patchy and sparse distribution.

Indices of breeding population size

An on-going program, in which nest mounds are mapped within permanently fixed grids, has been established in South Australia in order to:

- ***determine densities of breeding birds within the current range of habitats supporting malleefowl,***
- ***detect changes in densities over time and***
- ***provide quantitative assessments of the effectiveness of management programs.***

Although malleefowl are large birds, their secretive, ground-dwelling habits and camouflaged colouration makes them extremely difficult to count accurately. Declines in the number of birds in an area are also, therefore, very difficult to detect. The numbers of breeding pairs in an area can be estimated by monitoring the numbers of active nest mounds, which are relatively easy to locate.

In an attempt to measure the relative abundance and assess changes in local breeding densities of malleefowl a program of nest mapping has been initiated in selected districts across South Australia. Standardised 200 x 200 metre mapping grids covering between 250 and 420 hectares were established in areas of malleefowl habitat in Ferries-McDonald Conservation Park (unpublished data) and in Bakara Conservation Park and the adjoining H. Short Heritage Agreement area in 1989 (Brandle 1991). Further grids were established at Pooginook Conservation Park in 1990, at Cooltong Conservation Park (Booth's study site) and in Danggali and Mt. Scott Conservation Parks in 1993, and in R. and H. Martin's Heritage Agreement area near Cowell on Eyre Peninsula and on Chowilla Regional Reserve near Renmark in 1994. Grids have also been marked out and partially established at Innes National Park on southern Yorke Peninsula and on Calperum Station near Renmark. Geographic locations of these grids are shown on Fig. 2.

Grids were marked with steel posts at 200 metre intervals along lines approximating Australian Mapping Grid lines (e.g. on 1:50,000 maps) for ease of future reference. Grid lines across the grids were further marked with coloured flagging, with aluminium flagging or with red reflectors at 20 to 50 metre intervals (depending on visibility through the scrub) to enable ready location of reference grid posts during monitoring work.

Malleefowl nest mounds were located within the grids by teams of (usually) 12-20 observers who walked in a line across the grid between two rows of grid markers and flagged grid-lines (see Brandle 1991 for more detail). This work was conducted primarily in late spring or early summer when all current season's nests should contain incubating eggs and the relatively single-minded malleefowl were least likely to be disturbed. Positions of all nests found on a grid were then recorded in terms of distance and compass-bearing from the nearest grid marker post and marked

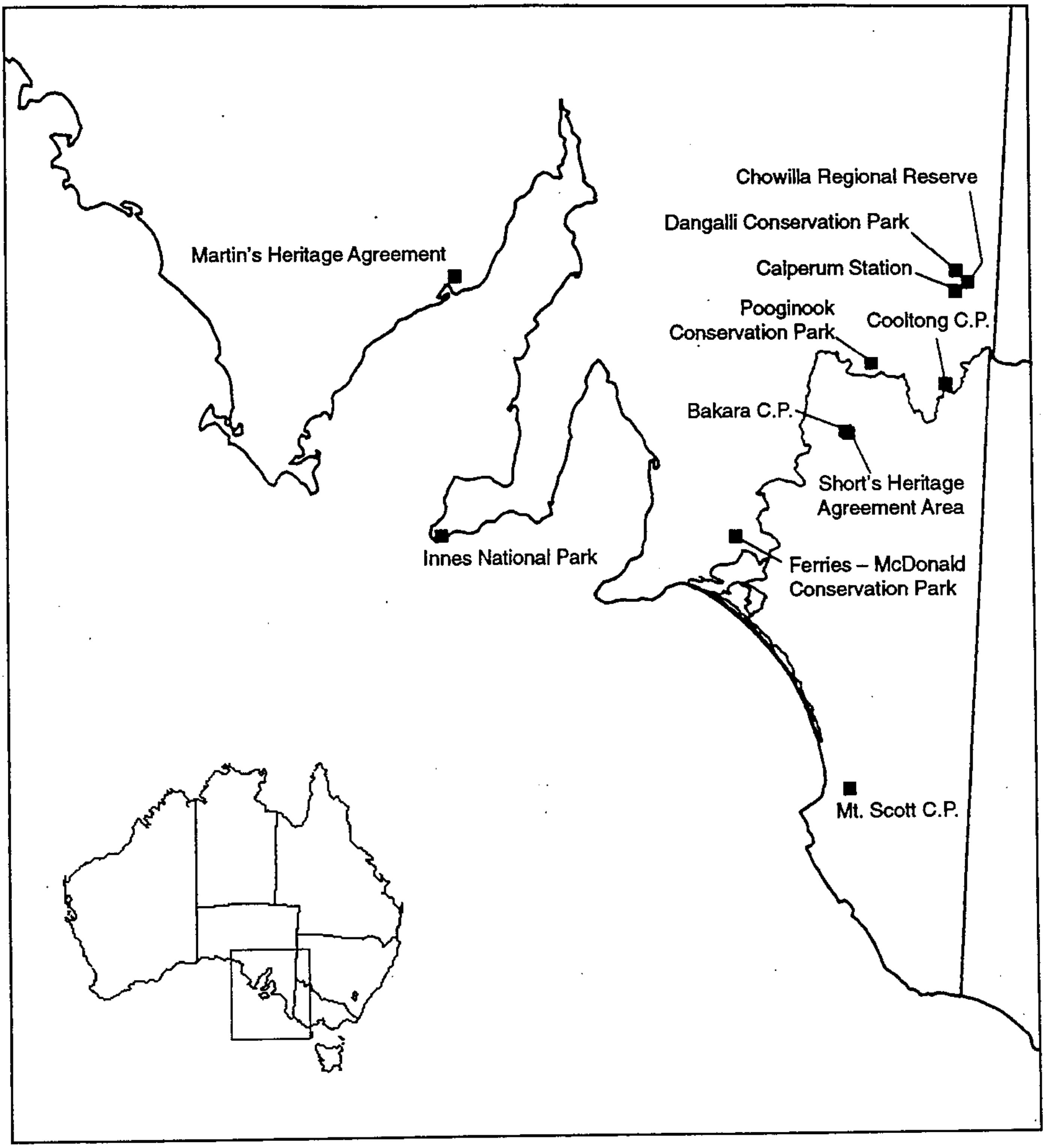

Figure 2: Location of Malleefowl Nest Mapping Grids in South Australia

accordingly on a grid-map. Nests were noted as either current season's, recently used (probably last 2-3 years) or not recently used (probably more than 3 years).

Active nest numbers could then be used to obtain an index of densities of breeding pairs as a basis for future monitoring work either in the short, medium or long term with the ultimate aim of detecting significant changes within these time frames.

Data on active nest densities at established monitoring grids in South Australia are summarised in Table 1 below.

Table 1
Malleefowl nest mound densities recorded at monitoring grids in South Australia 1989-94

		Total Number of Malleefowl mounds (Number of active mounds in brackets)					
Grid Location	Grid Area (Ha)	1989	1990	1991	1992	1993	1994
Bakara C.P.	420	52 (11)	49 (11)	50 (9)	-	-	-
Short's H.A.	250	33 (7)	-	34 (7)	-	-	-
Ferries-McDonald C.P.	350	7 (1) (100 ha. only)	38 (10)	42 (11)	49 (10)	49 (7)*	-
Pooginook C.P.	400		21 (6)	?	21 (12)	29 (13)	27 (9)
Mt. Scott C.P.	312				13 (3) **	estab.	-
Innes N.P.	400			part estab.	-	14 (9) ***	-
Cooltong C.P.	400				**	36 (14)	36 (16)
Danggali C.P.	200			**		13 (2)	15 (1)
Chowilla R.R.	200						19***
Calperum Station	200						part estab.
Martin's H.A.	550						estab.

* 100 ha. surveyed intensively; remaining 250 ha. only known active mounds from previous search monitored
** survey data only for search along dune transect outside of grid
*** incomplete survey

Clearly, there is a need to complete mapping of several of these grids and to re-survey others. There is also a need to establish grids in other geographic areas of the state. Although the mapping technique provides us with our most accurate indices of changes in breeding densities and is one of the major research and monitoring priorities for the recovery of the species, state and federal governments do not have the staff resources to conduct these surveys without the involvement of many other people. The establishment and monitoring of grids has been accomplished largely through the contributions and enthusiasm of community groups and individuals. What is needed to increase the effectiveness of the program is the co-ordination of survey support.

The available data suggest that there are currently between about two and four breeding pairs of malleefowl per square kilometre (or per 100 ha.) on most grids at most times. The breeding densities recorded to date in South Australia are comparable with those found in Victoria by Benshemesh (1992) and in New South Wales by Brickhill (1987). These appear, intuitively, to be consistent with what might have been expected, on average, for such areas over the past 200 years. At present, however, neither the numbers of grids mapped nor the numbers of annual repeats for any particular grid are sufficient, given the considerable seasonal variations experienced, to interpret any population trends to date.

Interpretations of population trends are complicated by several factors. Comparison of maps of particular grids over successive years (see Figures 3 and 4) show, as for similar studies elsewhere, that different combinations of nest mounds are used from one year to the next. That is, pairs of malleefowl do not use the same nest mound every year. As a consequence of this, and because no grids mapped to date cover entire scrub blocks, some birds may move off-grid to nest in some years resulting in a slight decrease in the number of active mounds recorded. Similarly, in some years additional pairs of birds may move onto the grids and cause slight increases in numbers. In still other years such movements will balance out. These fluctuations need to be considered when attempting to interpret annual data.

Another confounding factor is that changes in the numbers of active nest mounds from one year to the next may be a function of differences in seasonal rainfall. Birds will abandon their nests altogether during severe droughts. Data must be collected over many seasons to determine changes associated either with declines in breeding density or with recruitment into the breeding population.

In addition, interpretation of nest mapping data requires access to and assessment of a thorough description of how the surveys were undertaken. For example, the Ferries-McDonald grid data for 1993 are based on a check of the previous year's active nests and an incomplete search of grid-cells. Active nests were therefore almost certainly missed and this survey cannot be compared with previous surveys to determine changes in breeding density. The data for the Cooltong grid for 1994 were subject to question because they were inconsistent with all other grids surveyed in South Australia and Victoria where the number of active nests suffered declines as a result of the severe drought. In fact the Cooltong grid was surveyed thoroughly by an experienced group of volunteers and staff. Although the total annual rainfall near the park was well below average, the unusual nesting pattern may have been stimulated by relatively large rainfalls in June and September prior to the survey. Thus the timing of the survey, the techniques used to survey, the seasonal conditions, the number of surveyors and the experience of the participants can all effect the results of the

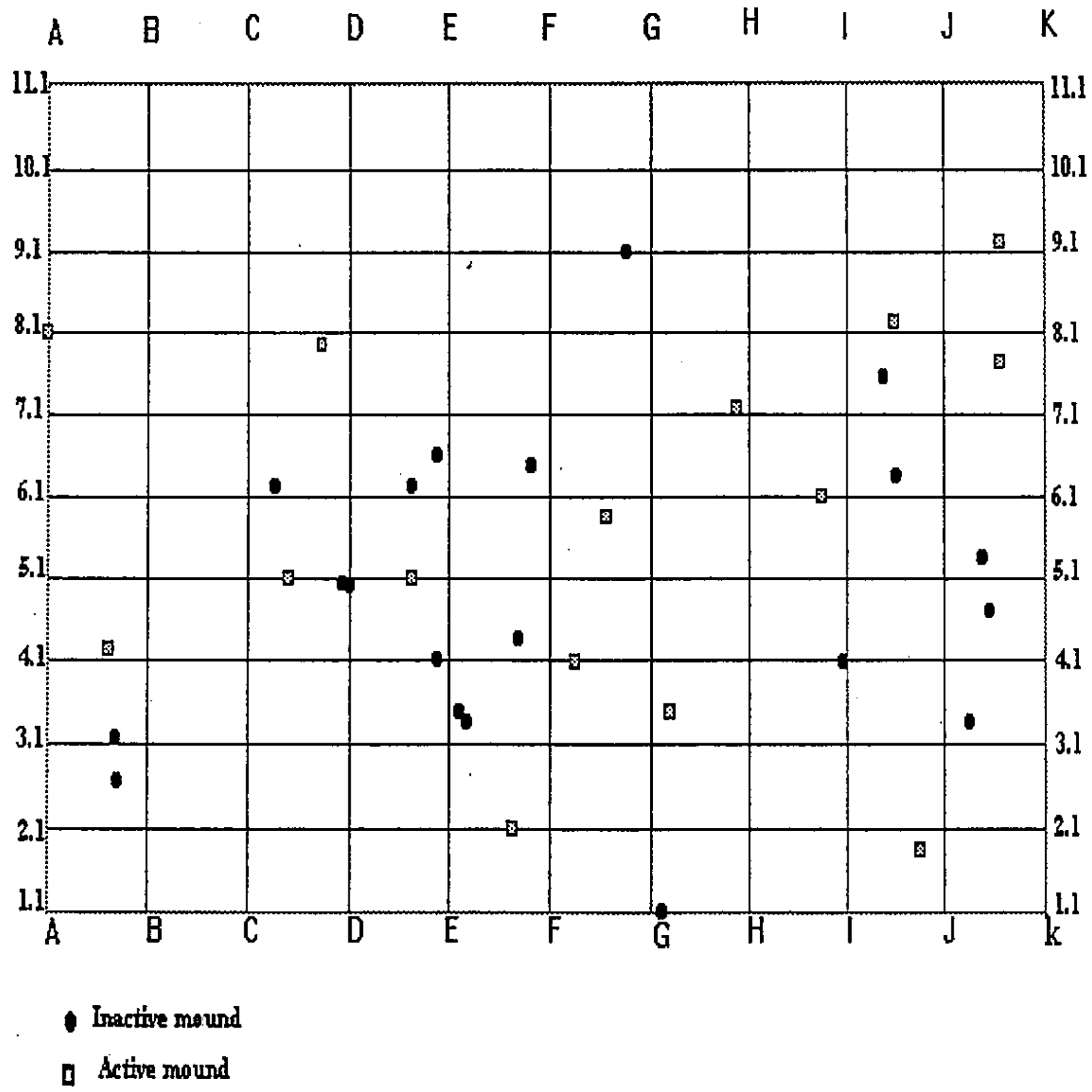

Figure 3: Cooltong Malleefowl Survey 1993
Relative positions of active and inactive nest mounds
within permanent monitoring grid

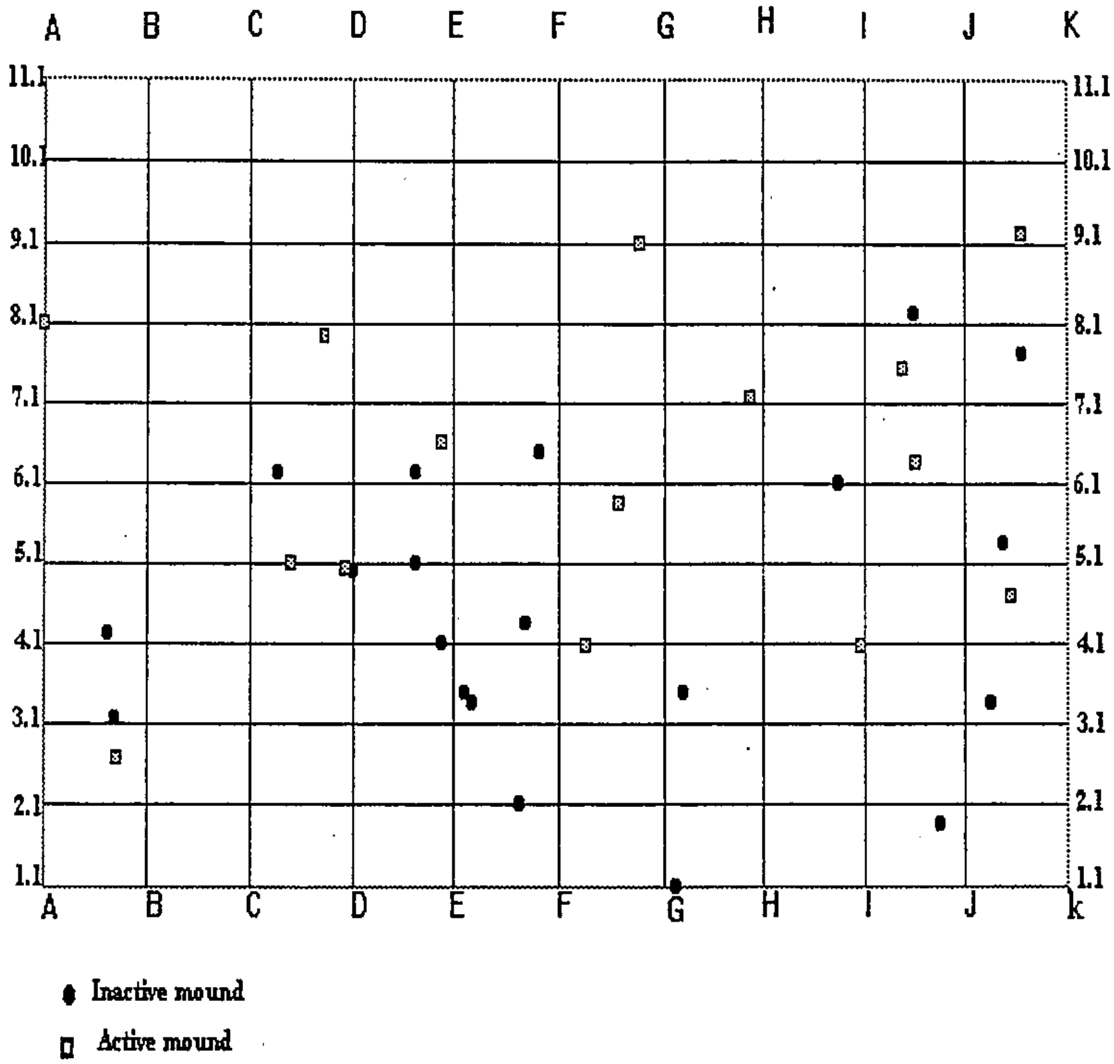

Figure 4: Cooltong Malleefowl Survey 1994
Relative positions of active and inactive nest mounds
within permanent monitoring grid

survey. This information is not always available. Clearly, in future, recording of more complete and consistent grid data is required.

Furthermore, while such indices of breeding densities are a very useful and straightforward population parameter to measure, there are situations where they may be misleading and these need to be considered when interpreting nest activity data.

Firstly, male malleefowl will work nest mounds when they do not have a mate, especially if they start a season with a mate and lose her early on; that is, the male continues to work the mound regardless (e.g. Weathers, et al. 1989).

Secondly, while an active nest mound usually indicates the presence of an adult pair of malleefowl, it does not always indicate successful reproduction. This may be due to several reasons including production of infertile eggs and/or predation of eggs from the nest. The former situation may be due to one or both birds of a pair being very old, as is occasionally indicated by abnormal, often small eggs (Priddel pers. comm.). This might be expected to occur with greatest prevalence in small habitat remnants with small numbers of malleefowl and negligible to nil recruitment. Unproductive nests may also go undetected in situations where foxes (and perhaps goannas) regularly remove eggs from the nest but the malleefowl continues to work the mound. In this way the most obvious signs of predators (diggings and tracks) will be quickly covered through the working of the mound by the bird (although fresh egg shells may be found nearby).

Thirdly, small "practice" nests made by sub-adult birds will often be worked regularly without eggs being present.

It is, therefore, a useful and informative exercise to excavate selected nest mounds in an area to determine a range of reproductive parameters.

Reproductive Success

The reproductive success of a pair of malleefowl can be affected by various factors; understanding these factors assists conservation managers with developing effective strategies to preserve and enhance remnant populations.

Reproductive success of malleefowl is, as illustrated in the previous discussion, dependent upon many factors.

Firstly, seasonal conditions determine whether the composting part of the malleefowl's nest chamber will function sufficiently to incubate eggs. If incubation is possible, then its success is dependent upon the fertility of both the male and female birds, the experience and skill of the male at maintaining appropriate nest conditions without damaging eggs, and the survival of the male during the nesting season to complete incubation.

Fecundity (the number of fertile eggs laid) is, in turn, largely dependent upon seasonal conditions and the female's ability to maintain her energy requirements while producing and laying proportionately very large eggs.

Hatching success is determined largely by the nest maintenance skills of the male, especially his skills in maintaining incubation temperatures. Hatching success can also be reduced by predation of eggs from nests and the failure of embryos to develop fully due to genetic defects caused, for example, by inbreeding depression or effects of old age.

Recruitment of the hatched chicks into the breeding population at three to four years of age - the ultimate measure of reproductive success - is a much more difficult parameter to measure. This difficulty is due both to the relatively long time frame over which a population must be monitored to obtain useful information and to the low probability of a chick reaching adulthood. However, the very earliest stage of this phase where the hatched chick has to dig its way out to the nest's surface through 30-50 cm. of soil and litter can be assessed at monitored mounds. Early signs of recruitment of sub-adult birds into the breeding population may also be recorded as small, new "practice" nest mounds located on previously mapped grids (see Table 3 below). These nests usually have no eggs or fewer eggs than the more established, larger nest mounds.

As a baseline for assessing some of these parameters, fecundity and hatching success were examined for active nests monitored in the Bakara/Mantung area during the 1990-91 breeding season (S.A. D.E.N.R. unpublished data) and in Ferries-McDonald Conservation Park during the 1992-93 breeding season (M. Pearsons unpublished data). Eggs were excavated from nests in both districts on several occasions during the season and identified with sequential numbers written in large numerals on the shells with pencil. Some eggs from some nests in the Bakara/Mantung area were later removed and artificially incubated at captive raising facilities at National Parks and Wildlife Service facilities at Monarto. Others were monitored, *in situ*, until hatching or until the end of the nesting season when the male ceased working the mound (or no eggs had been laid for 70 days or more).

The numbers of eggs laid and the numbers hatched from a range of malleefowl nests in the Bakara/Mantung area and in Ferries-McDonald Conservation Park on these occasions are summarised in Tables 2 and 3 below. Table 4 provides a comparison of some of these data with those obtained previously from other areas.

Table 2
Malleefowl egg laying and hatching data recorded for nests in the Bakara/Mantung area, 1990-91

Mound Number	Min. No. Eggs Laid	Eggs Hatched (in wild, Monarto facility)	% Eggs Hatched	Eggs Rotten, Broken	Eggs Predated	Eggs Infertile	Dead Chicks
1	12	5 (1, 4)	42	3	-	4	-
2	10	10(5,5)	100	-	-	-	-
3	12	7 (3, 4)	58	2	-	3	-
4	8	7 (2, 5)	88	-	-	1	1
5	5	4 (2, 2)	80	1	-	-	-
6	6	5 (-, 5)	83	-	-	1	-
7	9	8 (3, 5)	89	-	-	1	-
8	17	13(3, 10)	76	3	-	1	-
9	18	9 (4, 5)	50	4	-	5	-
10	12	10(8, 2)	83	-	-	2	-
11	17	7 (3, 4)	41	3	-	7	-
12	12	9 (2, 7)	75	2	-	1	-
Total	138	94 (36, 58)	68.1 (75, 64.4)	18 (13, 5)	-	26 (3, 23)	1

Note: Mounds 1-4 were visited twice, on 12-14 December 1990 and 7 January 1991. Mounds 5 and 6 were visited only once on 20 December 1991. The mounds monitored in Bakara Conservation Park (7-12) were checked three times, on 20 December 1990, 11 February and 20 March 1991.

The monitoring at Bakara Conservation Park in 1990-91 revealed that most nests had hatched at least one egg before the middle of December. This indicated, from a mean incubation period of 62 days, that egg laying began in the area in mid-late September. In fact, a malleefowl had been filmed laying an egg on a property adjacent to Bakara Conservation Park on the morning of 20 September 1990. The same bird was also observed laying another egg on 29 January 1991. The timing of hatching suggests that egg laying continued in some nests until about late February or early March.

Hatching success rates in the wild and in artificial incubators at Monarto were very similar and compared favourably with similar previous studies (see Table 4). However, it is worth noting that there was a much higher incidence of infertile eggs among those that had been collected from the wild and incubated artificially, while in the wild there was a greater incidence of damaged (rotten/broken) eggs. Neither occurrence was evenly distributed between nests/pairs, suggesting that these "problems" were associated with particular birds or nest locations. In the case of infertile eggs, either the birds were producing a preponderance of such eggs or there may have been problems in transporting them to Monarto. The rotten/broken eggs in some nests may have been due to the male cracking them while working the nest mound or alternatively to predators digging down to the eggs, eating the contents and leaving the empty shell(s) in place. In such instances egg predation would not have been noted.

Table 3
Malleefowl egg laying and hatching data recorded for nests in Ferries-McDonald Conservation Park, 1992-93 (M. Pearsons unpublished data)

Mound No.	Min. No. Eggs Laid	Eggs Hatched	% Eggs Hatched	Eggs Rotten, Broken	Eggs Predated	Eggs Infertile	Dead Chicks
1	12	8	67	3	-	1	-
2	2	1	50	-	1	-	-
3	8	1	13	-	7	-	-
4	1	0	0	-	1	-	-
5	4	3	75	-	1	-	-
6	4	3	75	-	-	1	-
7	6	5	83	-	1	-	-
8	4	2	50	-	1	1	-
Total	41	23	x=56%	3	12	3	0

Note: Mounds 1, 2, 3 and 6 were examined on three occasions, on 18 November 1992, 27 December and 15 March 1993. Mounds 5 and 8 were checked only twice, on 18 January and 15 March 1993. Mound 4 was a new "practice" mound and was examined four times, on 18 November, 11 and 27 December and 15 March. Mound no. 7 was also checked four times, on 18 November, 27 December, 19 January and 15 March. Two additional "practice" mounds (Z44 and Z46) with no eggs present were also checked on 18 January and 15 March 1993.

One of the most interesting findings of the Ferries-McDonald study was the relatively high proportion of predation. One nest (no. 3) experienced an 87% predation rate, indicating almost certainly that at least one local fox had learnt how to obtain eggs from nest mounds. During the following season, poison meat baits were buried in the sides of active nest mounds at Ferries-McDonald Conservation Park to counter this problem.

Table 4
Relative fecundity data from five studies of malleefowl in South Australia and New South Wales

	Study and Years				
	Frith (NSW) 1950s	Brickhill (NSW) 1981-84	Booth (SA) Cooltong C.P. 1981-85	Bakara C.P. area (SA) 1990-91	Ferries-McDonald C.P. (SA) 1992-93
Sample size	62 clutches	34 clutches	22 clutches	12 clutches	8 clutches
Mean Ann. Rainfall (mm)	411	411	240	250	???
Mean Density Active Nests	2.5 during drought 5.5 in 1958-59	2.0	0.9	1.4	3.5
Clutch Size (range)	5-33	3-33	2-34	5-18	1-12*
Clutch Size (mean)	17.6	15.6	13.8	12.7	5.1*
% Hatching	49.5	51.3	79.2	68.1	56
Mean No. Hatching	8.9	8.0	10.9	7.9	2.9*

* The Ferries-McDonald Conservation Park data used here are for a relatively small sample size (8 nests only) including a "practice" mound that had only one egg. The season was very late in starting with good falls of rain not occurring until late in spring.

Assessment of Threats to Malleefowl Populations

The programs for managing remnant populations of malleefowl in South Australia have been based upon research programs that have elucidated the significance of processes threatening the long term stability of the species, in particular predation by introduced predators and the fragmentation and degradation of favoured habitats.

Impacts of Introduced Predators on Population Stability

Introduced foxes are known to prey on all stages of the life cycle of the malleefowl. High predation rates on eggs were recorded by Frith (1959, 1962) in central New South Wales, but more recent studies have recorded negligible levels in SA (Booth 1987b), N.S.W. (Brickhill 1987b) and Victoria (Benshemesh 1992).

By comparison, malleefowl chick mortality due to predation is consistently high and often largely attributable to foxes. In N.S.W., Priddel (1990) found that foxes take at least 40-60% of chicks, while Benshemesh (1992) found that about a third of deaths of radio-tracked chicks were due to foxes and possibly cats. Both authors reported about 80% mortality of chicks within two weeks of release throughout their studies and in neither case were any chicks known to survive more than a few months. Other major causes of death were predation by raptors and metabolic stress (probably starvation).

Foxes are also known to take adult malleefowl (Frith 1962; Booth 1987b; Priddel and Wheeler 1990; Benshemesh 1992; Williams unpublished data), but most studies have shown both low levels of predation and long-term survival of the adult birds at various study sites (e.g. Frith 1962; Benshemesh 1992). Raptors, such as goshawks, falcons and wedge-tailed eagles, and feral cats also take sub-adult to adult malleefowl, but apparently at a low incidence.

Despite these apparently drastic statistics, adult malleefowl ("the few survivors") are generally long-lived birds in the wild and are likely to produce 100-200 young in their lifetime (10-25 eggs per average to good season, at 60-80% hatching rate for 15-20 years). They are, therefore, a species evolved to tolerate up to 98% mortality at some stage of the life cycle.

In Victoria, the degree of impact of fox predation on malleefowl populations is thought to be related to the size of the habitat patch and the quality of that habitat for malleefowl (Benshemesh 1994). This almost certainly applies across the range of the malleefowl including its arid extremes. However, the Victorian statement was directed primarily at habitat remnants in agricultural districts. Fox densities are considerably higher in habitats adjacent to agricultural land (Benshemesh 1992) compared with further away from such land, and are more likely to depress malleefowl populations in marginal habitats or remnants where the species' hold may already be tenuous.

Direct assessments of predation

Data obtained from mapping malleefowl nesting activity within permanent grids have provided useful indicators of survivorship of adult malleefowl in those areas where nests have been mapped, especially over two or more years. That is, it appears as though most breeding pairs have survived the breeding seasons monitored to date and that several pairs, at least, may have survived several years if re-use of particular mounds effectively assesses survivorship.

Additional data were obtained for malleefowl in the Bakara and Ferries-McDonald Conservation Park areas when nests in each area were excavated to mark eggs for later removal and artificial incubation. In this way losses of eggs to nest predators (foxes or goannas) were noted. As discussed above, such predation of eggs was noted at Ferries-McDonald C.P. in 1992-93 (see Table 3).

The eggs obtained for artificial incubation were hatched and the chicks raised to about 6-8 months of age (or at least 1 kg body weight). All chicks were then sexed laproscopically by a veterinarian and 15 Bakara birds and 15 Ferries-McDonald birds were selected for trial releases back into the two parks where their eggs had originated. Each bird was fitted with a back-mounted, harness-attached radio-transmitter with 'mortality sensor' following the methods used by Priddel in New South Wales (Priddel & Wheeler 1990). After release, birds were monitored daily for three weeks (by Priddel & Wheeler for the first two), then weekly for 2.5 to 3 months at which time the transmitter batteries on the remaining birds failed prematurely. Using this technique birds were usually sighted during each monitoring period in which they were searched. However, most search effort was put into locating birds with a transmitter emitting an increased signal pulse-rate, which indicated that the transmitter had not moved for 12 hours and that the bird was, therefore, probably dead. Causes of death were investigated when corpses were found and, where necessary, by post mortem.

During these trials, most birds died within the first two to three weeks. Most deaths were attributed to predation by foxes and the corpse remains were usually found partially buried in the soil or leaf litter. However, two birds survived for the duration of the radio-tracking monitoring period (3.5 to 4 months) at both parks, suggesting that they had developed appropriate predator avoidance skills and may have been able to survive for much longer.

In the following spring, further trial releases of 11 to 12 month old (≥1 kg) captive-raised malleefowl fitted with radio-transmitters were attempted in the Bakara/Mantung area and the Swan Reach Conservation Park/Yookamurra Sanctuary area. The objective of this release was to assess the ability of a fox control program, which had been initiated a year prior to the releases, to increase the survivorship of young malleefowl. Unfortunately, most radio-transmitters failed within the first two to three days and monitoring could not be conducted satisfactorily. Nevertheless, none of the birds that were located during the one to two weeks in which their transmitters were functional succumbed to fox predation while birds that had been released on nearby farms where foxes had not been culled were taken by foxes. Two birds with working transmitters survived in the Swan Reach Conservation Park area for at least three months (one moving up to 15 km away) suggesting that if captive-reared birds could avoid predation by introduced predators they may be able to adapt successfully when released into non-captive environments.

Indirect assessments of predation

An indirect assessment of the effects of predation by foxes was put in place in 1991 with the establishment of a fox baiting program in the Bakara/Mantung district. This has been a local community program, initially involving 12 contiguous properties bordering and buffering the malleefowl nest grid areas on Bakara Conservation Park and H. Short's Heritage Agreement. This baited area has now been expanded through the inclusion of several additional properties in the community baiting program, increasing the buffer effect.

To begin with, the program was established using strychnine baits, as these were the only option available at the time. However, a well-argued case was put to the South Australian Health Commission to allow a trial use of 1080 meat baits and a license was granted. This was the first use of 1080 meat baits allowed inside the agricultural areas of South Australia and has now become accepted (under strict controls) as the most effective means of controlling foxes in such situations. The culling of foxes with baiting programs is now a more common undertaking in South Australia and has had the effect of enhancing both pastoral productivity and wildlife conservation.

If fox predation is having a significant negative impact on malleefowl recruitment, a successful Bakara/Mantung fox baiting program would be expected to lead to increased recruitment of malleefowl and, eventually, a significant increase in the number of active nests on the district's two mapping grids. However, such an increase may also be influenced by removal of rabbits from these areas. As rabbits are a likely competitor of malleefowl and a major food of foxes in the agricultural districts, their control has been an integral part of the Bakara/Mantung district conservation effort.

Unfortunately, the two nest monitoring grids in this area have not been surveyed since 1991-92, so any responses of malleefowl to the fox and rabbit control programs have yet to be determined.

Competition for Food Resources

Malleefowl are generalist omnivores that eat a wide range of vegetative and invertebrate food items. In a recent study in western New South Wales, Harlen and Priddel (1993) found that food was most abundant in August and November, and that availability declined during summer, especially February. Herbaceous food resources are concentrated in the cooler, moister months, usually from August to October. At other times herbaceous foods are scarce and consist largely of hardier grasses and forbs. Similarly, Harlen and Priddel (1993) found that shrub-derived food resources, such as flowers, fruits or seeds, were characterised by brief periods of abundance followed by months of low availability, usually with great variability from one year to the next. By comparison, ground-dwelling invertebrates of various kinds are available throughout all times of the year, but primarily spring and early summer, with ants and spiders most abundant during summer when other food resources are scant (Harlen and Priddel 1993). As a consequence of the vagaries of availability of these various food resources, malleefowl have evolved an opportunistic feeding strategy. This is exemplified by the discovery of dozens of wild turnip seeds in the crop of one bird killed by a fox and a large number of lerps in the crop of another.

Malleefowl densities are known to be severely reduced in areas grazed heavily by sheep, and a similar effect is likely where other introduced or native grazers are over-abundant. Frith (1962) reported from his studies in New South Wales that habitats grazed by sheep supported only 9-16% the density of breeding malleefowl pairs that were supported by ungrazed habitat. This was thought to be due to competition for food supplies because continual sheep grazing prevents regeneration of many herb and shrub species, thereby reducing both food availability and the amount of cover (from predators) available for malleefowl.

Breeding densities of malleefowl in adjacent areas of similar habitat with and without frequent stock grazing could give a reasonable index of the effects of stock on malleefowl in at least some areas of South Australia. Grids on Calperum Station, Chowilla Regional Reserve and Danggali Conservation Park (all part of Bookmark Biosphere Reserve) have been established, in part, to examine this. Similar comparisons could be made on Eyre Peninsula.

Off-Target Poisoning During 1080 Control of Rabbits

As 1080-poison baiting programs using 1080 in oat grains are widespread across the agricultural areas of SA to control rabbits, and as malleefowl eat seeds including spilled grain in paddocks and along roadsides, many people have expressed concern about the likely effects of the 1080 poisoning programs on malleefowl. Because rabbit baiting is a recommended practice for enhancing the quality of malleefowl habitat and because no studies on the effect of 1080 on malleefowl had been recorded in the literature, 1080 tolerance trials on malleefowl were arranged with Dr. Dennis King of the Agriculture Protection Board in Western Australia. These trials required giving malleefowl known dose rates of compound-1080 poison and measuring the resultant concentration of another chemical (citrate) in the blood after a set time. The LD50 (lethal dose for 50% of the population) for malleefowl could then be determined from the amount of citrate recorded without having to kill any birds.

The unpublished results obtained to date have been mostly from South Australian and New South Wales birds and have indicated that malleefowl are among the most tolerant of Australian birds to 1080 poison, and second only to emus. The advice from Dr. King has therefore been that malleefowl should not be at risk from 1080 poisoning programs to control rabbits. In support of this finding, is the relative prevalence of malleefowl in areas where such programs have been ongoing over several years. In the Bakara/Mantung district pairs of birds that have traditionally nested and fed along the edge of wheat paddocks have continued to breed successfully during the past five years of rabbit baits being laid along the same scrub edges.

Habitat Fragmentation

Habitat fragmentation, especially where resultant habitat remnants are small, can increase the vulnerability of malleefowl to local extinctions in a variety of ways. For example, the smaller the remnant the greater the probability that wildfire will devastate the remnant and remove the local malleefowl population (either through death or dispersal to nearby remnants. Similarly, the smaller the habitat remnant and the greater the ***remnant perimeter : remnant area*** ratio, the greater is the vulnerability of the area to "invasion" by predators and rabbits (Benshemesh 1992).

Small remnants may support small numbers of malleefowl for many years. However, the probabilities of these surviving in the longer term decline with increases in isolation of the remnant, increases in predation and competition, and decreases in remnant area and population size.

For these reasons, the plotting of malleefowl presence/absence information against remnant-size data should be instructive for both the short term appraisal of current malleefowl status and for the longer term monitoring of population trends (especially in smaller remnants). Identification of the smallest remnants with malleefowl present has therefore been an objective of the general survey of current distribution. Joanne Cutten (in press) has undertaken a questionnaire survey of landholders in the most developed agricultural districts of South Australia to address these issues. She found that there were only two records of habitat patches of less than 100 hectares that still contained malleefowl in the Murray Mallee region and three of a similar size in the South-east region. In the southern districts of the Murray Mallee where habitat fragments are small and isolated, she found very few blocks that still contained malleefowl. If small remnant blocks of mallee habitat adjoined large state reserves, such as Billiat Conservation Park and Peebinga, she found that the number of blocks supporting malleefowl increased. Similarly in the South-east region, the larger and more contiguous the blocks of remnant vegetation were, the more frequent was the occurrence of malleefowl. In districts where much of the vegetation had been cleared and remnant blocks are small and isolated, malleefowl populations have recently experienced local extinctions.

On the other hand, much of the South-eastern habitats may have always provided sub-optimal habitat for malleefowl and low numbers of malleefowl may have occurred in this area prior to European settlement. It is still unclear whether malleefowl were always rare in areas such as Big Heath Conservation Park, where malleefowl are suspected to have experienced recent local extinctions (Cutten in press) or whether habitat fragmentation and the subsequent invasion of foxes and degradation of habitat by rabbits and livestock led to the observed declines.

Follow up systematic monitoring of such small remnant populations may provide insights into a range of population parameters. Apart from the impacts of fire, predation and competition, such issues as fertility, fecundity, inbreeding depression and longevity of malleefowl may also be assessed. Habitats where malleefowl are now considered extinct are still being identified.

Effects of Fire on Habitat Quality

Fire reduces quality of nesting and sheltering habitat for malleefowl for many years after its passing. However, it often serves to renew habitat structural diversity and overall species diversity over several years and thus, if on a proportionately small scale (compared with the total area of habitat), probably benefits local malleefowl considerably. Unfortunately such beneficial effects of fire seldom occur for malleefowl today because the scale of most wildfires is proportionately very large, consuming many habitat remnants almost entirely. Even many of the largest mallee reserves have large proportions of their total areas burnt on a regular basis, destroying the habitat of many established malleefowl pairs and increasing their vulnerability to predation by foxes, cats and raptors. For all of these reasons, Benshemesh (1992, 1994) has suggested that more effective fire control may be the single most important factor in improving the conservation status of malleefowl in Victoria.

In South Australia, no malleefowl population assessment and monitoring grids have been established in relatively recently burnt habitats where malleefowl are known to occur. Such a grid or grids could be very informative, especially if comparisons are made between large remnants and relatively small, isolated remnants. Although such a study has not been initiated in South Australia, it needs to be recognised as an objective of the South Australian program. In particular, an area needs to be identified immediately after a spring or early summer fire has passed so that all active nests at the time of the fire can be recorded as the "before fire" baseline data.

In Victoria, Benshemesh (1995) has found that malleefowl nesting densities in a grid-mapped area (Moondah Block) burnt in January 1985 have gradually returned to almost pre-fire levels. Where ten birds nested before the fire, none bred the following spring, four pair bred during the second and third seasons and eight pairs bred during the ninth season following the burn. Such recoveries must, however, be interpreted in terms of recruitment of pairs from adjacent unburned habitat and in terms of the mortality of individuals during the burn. Further studies should consider the effect of intense burns in small isolated remnants on subsequent recruitment into the breeding population.

Illegal Hunting of Malleefowl

Hunting of malleefowl has declined in South Australia since the enactment of the National Parks and Wildlife Act in 1972 and since wildlife conservation has become an important component of most education curricula. Nonetheless, poaching in some of the closely settled regions of South Australia continues to threaten the viability of malleefowl populations. For example, four incidences of malleefowl being taken with firearms have been reported in one conservation park in the Murraylands Region within the last three years (National Parks and Wildlife Service unpublished data). In one incident, at least three adult birds were killed. Further education programs are clearly needed to develop an awareness amongst the general community of the threat of such activities to the survival of local malleefowl populations.

Management Actions in South Australia

Protection of Malleefowl Habitat

Clearance Control

Malleefowl habitats in South Australia have been protected from broadacre clearance for agriculture since the passage of the Native Vegetation Management Act, 1985. However, broadacre losses of habitat still occur temporarily across the malleefowl's range of distribution due to wildfires. Broadscale degradation of malleefowl habitat also occurs in areas with high stock grazing pressures and/or high rabbit numbers.

Fire Control

Land managers must first recognise fire as a threat to the continued existence of local malleefowl populations in order that malleefowl are effectively protected from wildfires. Key malleefowl habitats then need to be identified and protected with appropriately placed and maintained firebreaks. In many cases this involves surrounding entire habitat remnants with a firebreak, as is the practice for many parks and Heritage Agreement areas. In other situations, and especially where there are large areas of habitat, it may be more appropriate to strategically place extra firebreaks within the habitat remnant, park, Heritage Agreement area, etc. At Mt. Scott Conservation Park in the Upper South-East, a control burn firebreak is being contemplated as the most effective protection within a particularly fire-prone habitat.

Grazing Control

Rabbit control programs have been established in many areas inhabited by malleefowl. The best example of this in South Australia is in the Mantung/Maggea (Bakara Conservation Park) district of the Murray Mallee where an integrated rabbit and fox control program has now been in place since 1991, primarily aimed at conserving the local malleefowl population (see Williams 1995 for details). Here, rabbits are effectively controlled by coordinated fumigation and filling of burrows on several adjoining properties in late summer and early autumn. Prior to fumigation and wherever rabbit numbers are high, trails of 1080-poisoned oats are also laid to improve the levels of control. Such rabbit controls then have two add-on benefits for the control of foxes. Firstly, the sudden decrease in availability of rabbits as food for foxes means that the foxes are more likely to take 1080-poisoned meat baits, which are laid as a follow up to the rabbit control efforts. Secondly, if 1080-oats are used to control rabbits, many foxes may also die as a result of eating the poisoned rabbits. Thirdly, fox dens and litters are destroyed during the fumigation and rabbit warren ripping programs.

Protection of Malleefowl

Introduced Predator Control

As discussed above, predation by foxes and feral cats accounts for a major proportion of malleefowl chicks and sub-adults, and in some areas for eggs as well. Poison baiting for foxes has therefore been employed in several areas of the state in an attempt to assist malleefowl conservation.

The timing and placement of the baits is important in ensuring effectiveness. For example, in the Mantung/Maggea district, at and around Bakara Conservation Park, dried 1080-poisoned meat baits (containing 2 mg 1080 per 60 g of half-dried meat bait) are buried at a shallow depth in small raised mounds along fencelines, scrub edges and access tracks in autumn and again in spring. The autumn baiting is designed to target dispersing fox cubs and follows on from local rabbit control work. It is also timed to have maximum effect on fox numbers leading into the local lambing season. The spring baiting targets adult foxes and is timed to coincide with most foxes having established territories and denning sites. This baiting takes advantage of minimal dispersal of foxes during breeding thus enhancing the protection of malleefowl with a timely and effective fox cull.

In areas where fox predation of malleefowl eggs is known to occur, such as Ferries-McDonald Conservation Park, it is likely that only a small percentage of local foxes have learned to either excavate the eggs from the nest or raid the nest when the male malleefowl has the nest chamber exposed. Whatever the situation, such foxes have learned that the nest mounds can contain eggs, and may regularly check at least some of the active mounds in their area. They are therefore likely to take poisoned meat baits buried on the side of an active nest mound and this strategy has been used at a few locations. Although baits have certainly been taken by foxes (e.g. from 5 out of 6 nests at Ferries-McDonald C.P.), the effectiveness of this strategy in removing the actual egg robbers has not been measured.

Introduced Predator Exclusion

Predator exclusion fencing has been used to protect captive-raised malleefowl released into 1100 hectare Yookamurra Sanctuary in the western Murray Mallee. This area of mallee woodland and scrub historically supported a very sparse population of malleefowl, as indicated by the few old nest mounds present. Numbers were limited primarily because of a lack of suitable nesting sites on the shallow soils and sheet limestone. The malleefowl released unfortunately all eventually either flew over the fence to unprotected areas and/or were taken by birds of prey.

Similar releases of captive-raised malleefowl within a predator-exclusion area are proposed for Bretag Scrub at Monarto Zoological Park in the near future.

Translocations to Offshore Islands

The threats of habitat clearance and predation by introduced predators were recognised for malleefowl long ago and several attempts were made to establish this species on offshore islands. In particular, 30 malleefowl were released at Flinders Chase on Kangaroo Island between 1911 and 1948 (in 1911, 1923, 1924, 1936 and 1948) (Copley 1995). These introductions to apparently suitable habitat failed within a relatively short time, yet the closely related Brush-turkey (*Alectura lathami*), from apparently dissimilar habitats along Australia's east coast, established a successful population in Flinders Chase from just one pair of birds released in 1936!

A translocation of malleefowl was also attempted to Thistle Island in 1950 (Copley 1995), but no details are available and the attempt apparently failed early as there have been no records of malleefowl from the island since.

Further Monitoring and Research Programs are Required to Develop an Effective Program for Managing South Australia's Malleefowl Populations

Distribution and Relative Status

The current system of mapping active nest densities on marked grids has clear advantages in providing accurate indications of population "vigour" and responses to a wide range of influences. However, the amount of data collected from established grids is insufficient to draw the desired conclusions from. Certainly several of the grids need to be mapped thoroughly for the first time and others require follow-up surveying to examine local seasonal patterns of nest use. Additional grids in other areas of the state would also be advantageous in highlighting geographic variation in breeding densities, reproductive success and relative population status.

The distribution of malleefowl in western agricultural regions of South Australia requires further research. These data will be improved when the coverage of D.E.N.R.'s Biological Survey program reaches these areas. Surveys in the state's most remote northwestern regions are required to assess the extent of the distribution and abundance of malleefowl populations.

Effectiveness of Management Practices

The standardised grid-based mapping of active nest mounds is also important in providing a quantitative basis for assessing the effectiveness of local land conservation management practices. The more grids established and mapped (within reason) and the more often they are resurveyed, the more useful the data obtained will become. This arises from having more controls against which particular management practices can be measured. In particular, the establishment of monitoring grids are required to assess the long and short-term effects of fire on population viability of malleefowl in small and large areas of remnant mallee habitat.

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Mitigation of the threats to the survival of malleefowl, and procedures to maximise the success of reintroductions

Robert Wheeler & David Priddel

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The combination of land clearance, foxes, stock, goats, rabbits and fire has spelt disaster for the malleefowl *Leipoa ocellata*. Vast areas of prime mallee habitat, once supporting high densities of malleefowl, have been lost. The remnants remaining in New South Wales are discontinuous and contain only low densities of malleefowl. Populations of malleefowl in protected areas continue to decline, largely due to the predation of young malleefowl by foxes. Foxes prey so heavily on malleefowl that they severely restrict, or perhaps curtail, the recruitment of young into the breeding population.

A recovery programme for malleefowl in NSW was initiated by the NSW National Parks and Wildlife Service. The primary goal was to establish a single self-sustaining population of malleefowl on Yathong Nature Reserve. The main thrust of the recovery programme was to increase the survival of malleefowl by controlling foxes. Localised fox control using a single bait medium proved only partially effective in reducing foxes to a level where malleefowl survival increased. The use of a range of bait media, the advent of commercially-prepared baits, participation from adjoining land-holders, and indirect poisoning through rabbit baiting eventually proved successful.

Some captive-reared malleefowl released into fox-free habitat were killed by raptors, particularly in areas where the canopy was not contiguous. A re-introduction of captive-bred malleefowl into mallee with a dense understorey and more extensive canopy cover has been highly successful.

As well as the effect of predators, other factors which may influence malleefowl survival were considered. The availability of food to malleefowl in Yathong Nature Reserve during a twelve-month period was investigated. At no time was suitable food absent, but its composition and amount varied greatly from month to month. The relationship between feed availability and age of mallee was also examined.

Future re-introductions of captive-bred malleefowl will be timed to coincide with the period of maximal food abundance.

Malleefowl at Eyre Bird Observatory

Rod Smith

RAOU (WA Group)

Eyre Bird Observatory is the most remote of the RAOU observatories. It is situated on the Nullabor coast about 1200km by road from Perth and about 500km from Norseman, the closest town. The nearest habitation is the roadhouse at Cocklebiddy, 50km and one and a half hours away, on the Eyre Highway.

Such is the location of one of Australia's Malleefowl study sites.

Since 1989 investigations into the status of the Malleefowl at Eyre have taken the form of one-week or two-week courses in which the participants thoroughly searched three discrete tracts of woodland totalling 13 square kilometres for Malleefowl mounds. In two years all the mounds within those tracts were assumed to have been located.

The position of each mound was recorded after being determined by hand-held compasses and pacing. In 1990 and 1991 corrections were made to the recorded positions by two university students who applied their surveying skills and GPS knowhow.

In 1992, 1993 and 1994 Malleefowl were trapped and colour-banded. Only two birds were able to be captured each year and it seems likely that many more than that use the study area. Each mound in the largest search area is visited annually in October by which time it is likely that all active mounds are established. Active mounds are recorded, as are all sightings of Malleefowl. Apart from the two weeks each year, the observatory wardens visit active mounds and record bird sightings through the year.

Typically, three mounds are active annually (out of 25) and the locations of the active mounds vary from year to year. It is uncommon for a mound to be used in successive years. Three of the six banded birds have been observed since capture: one on the same mound later that season, one on the same mound in the next season and one in the same breeding season 500m from its mound. Each bird was captured on a mound which it was working. Each is assumed to be a male.

The value of community input to malleefowl conservation in WA

Susanne Dennings

Secretary, Malleefowl Preservation Society, Ongerup, Western Australia
Fourth generation on the family wheat and sheep property, which was settled in 1911.

Ongerup is a small country town of less than 200 residents situated 400km. south east of Perth. The average rainfall is approximately 400mm. Last year we experienced the second driest year on record (less than 200mm). During this dry period, one of our grid study areas revealed a new malleefowl mound in a creek bed which yielded much breeding activity – maybe this bird knew more than our weather bureau...

I have been invited to speak at this conference on behalf of community involvement for malleefowl conservation. I want to give you a run down on our community group, the "whys and wherefores" etc. and what the future holds for groups such as ours.

In 1992, a well known local bird carver was commissioned by a shire councillor to carve a malleefowl for display in our shire office. The "Gnow" (aboriginal name for malleefowl) is part of our *Gnow*angerup shire heritage and our shire fauna emblem. Our group T-shirts bear the "It's Gnow or Never" slogan as part of the West Australian malleefowl conservation push.

Our bird carver, John Davis, studied a malleefowl in captivity while working on the carving and during that time the bird was taken by a fox. This motivated John into immediate action. He returned to the area to gather concerned residents to take action on the malleefowl decline. So began the MALLEEFOWL PRESERVATION GROUP, electing John as the group's first president.

Since 1992 the group has been extremely active concentrating on community awareness, setting up a permanent fox baiting station study, field studies and the establishment of a malleefowl distribution map by way of sighting forms.

Membership to the Malleefowl Preservation Group started with the local concern for the loss of our shire emblem, however it has spread to all parts of the state from station properties north of Geraldton, east of Sandstone, Kalgoorlie and south to Esperance and the Eyre Bird Observatory on the coast.

To date 5 study grids have been established in the Gnowangerup and Jerramungup Shires. Two of these areas are in large State Government (Department of Conservation and Land Management) reserves, two on private property in remnant vegetation, and the third is in a small reserve which has not supported malleefowl for over thirty years.

One of the private remnant study areas has revealed a staggering 5-6 active mounds per km^2. The remnant of 138ha. is surrounded by cleared farm land – the initial study of this block revealed a total of 59 mounds of which 7 were active, 15 classed as recently active (within 1-4 years), and 37 old. A tractor break-down in the late 1950's is the reason we have this area left uncleared for the malleefowl.

The community awareness work of this group has concentrated on addressing schools, seminars and local shows as the members of the group feel strongly that without community support, any conservation project will not have the strength and following to continue. Since 1993 the group has grown to 250 financial members (approximately 600 individuals) and our "Malleefowl Matter" newsletter is our main source of communication to financial members.

We have received funding from the Gordon Reid Foundation (Western Australian Lotteries Commission) and Save the Bush (National Landcare Program). We commenced and remain a sub-committee of the local Landcare group however we have recently become incorporated in our own right.

To date 90% of the Malleefowl Preservation Group's work has been carried out on a volunteer basis. Malleefowl information and study sites in Western Australia are well behind – we have the highest populations of the birds, the least number of grids and the least access to information. The enthusiasm of the community can not be questioned however it is surely time that Western Australia is assisted by a major support effort from the Malleefowl Recovery Team and the National Malleefowl Research Plan Coordinators.

Conservation of Malleefowl on Army Lands in South Australia

Lawrie Bruggemann

Property Manager of the Defence Centre Adelaide
Responsible for for property matters for Defence throughout most of SA

In line with the long standing tradition in the Army of "volunteering" for additional duties, my section was "volunteered" for environmental duties approximately 5 years ago. Initially this was just for tree planting but now our role has extended to critically examining all Defence activities to minimise adverse environmental impacts.

This presentation is to brief you of the challenge that faces Defence in conserving malleefowl on Defence lands in South Australia and to outline our obligations under the Endangered Species Protection Act.

There are two Army areas in SA that have been put under scrutiny as to the existence of malleefowl. The first is Cultana which is between Whyalla and Port Augusta. Heresay from informed sources makes mention of the existence of old mounds in the area as well as a possible sighting of a bird from a distance. A search of the area was conducted in June with nothing discovered although I am told that the vegetation (*Eucalyptus socialis* dominant) and surroundings are ideal habitat. Work in this area has been placed on hold until further information becomes available and our priorities directed to Murray Bridge where the bird definitely exists.

The Murray Bridge Army Range is 100km. east of Adelaide and 7km. east of Murray Bridge. The range totals 4,200ha. with more than half covered by dense mallee vegetation in sand over limestone. Dominant vegetation includes *Eucalyptus socialis, E. gracilis,* and *E. incrassata.* Approximately 5 years ago, a fire burnt approximately half of the wooded area. Since that time the vegetation is starting to come back strongly.

Prior to acquisition in the 1960's, the area had been used as a live firing range under the Defence Act. Today it is still used for field firing. Therefore it must be considered that much of the area is contaminated with unexploded bombs (UXO). This is a real barrier against conducting a comprehensive survey of malleefowl numbers within the boundary. Despite the firing activity, the evidence exists that the bird is present in large numbers.

For some years now the vegetated areas have been designated as a conservation zone. There is no grazing permitted nor vehicle access off the main access roads. In some areas, foot traffic is permitted. Therefore the vegetation is generally pristine.

It is only in recent years that the awareness of Malleefowl has been raised. Actual sightings are occurring on a regular basis at various locations. Active and unused mounds have been found over most areas. I am proposing to establish grids over the three distinct sections initially using Army cadets and school students in the safe location and consultants in the remaining areas. By necessity this will be a slow process. Once the grids are established we will be able conduct a census to determine actual numbers. An appropriate threat abatement plan can then be developed.

Challenges facing Defence include:

a) Malleefowl numbers are unknown therefore no effective threat abatement plan can be implemented.
b) Ignorance. Most users would be unaware what a mound was. A handbook is being produced to alert users to what the mounds and birds look like.
c) Suspicion. The need to determine a balance between protection of malleefowl, as required by legislation, and Army use.

Once the census is completed and numbers identified the threat abatement plan will include:

a) Laying Fox-off in the near vicinity of the mounds.
b) Those mounds in the generally unused areas of the range would not be widely advertised. Mounds in areas that are used for training would need to be signposted.
c) Users of the range will, through the education process, be encouraged to report any sightings or mounds to Range Control.

This project is only a part of the environmental initiatives Defence is currently undertaking at Murray Bridge. Other projects include:

- Erosion/rabbit control. With the help of the Australian Trust for Conservation Volunteers (ATCV) this is currently proceeding.

- Revegetation. Army has large direct seeding projects with more than 290km. completed.

- Wetlands. Each day 3 million litres of treated effluent from Murray Bridge is pumped to the range and ponded instead of dumping it into the river. The system has transformed a former dry land site into a 100ha. wetland and has attracted wildlife in huge numbers. Army uses this water now for irrigation.

Malleefowl Preservation – A Farmer Initiative

Henry Short

Mantung-Maggea Land Management Group

For over a decade scrub clearance controls have applied in South Australia and conservation minded farmers have been able to take out Heritage Agreements on remnant scrub to conserve native flora and fauna for all time.

A group of farmers on adjoining holdings in the Mantung area of the Northern Murray Mallee decided to co-ordinate their efforts to save the malleefowl. Survival of the birds was threatened by loss of habitat and predation by foxes. A "Land Management Group" was set-up to co-ordinate rabbit and fox control. The Natural Resources Management Strategy of the Murray Darling Basin Commission has funded the project for its initial four years. Funding has covered most expenses relating to rabbit and fox control, other than farmers time and vehicle running costs, and has included purchase of baitlayers and fumigators. The most recent expenditure was the purchase of traps for feral cats.

The management activities include:

Rabbit Control

A baiting programme is undertaken at the end of summer. A high success rate is attributed to all farmers baiting at the same time. On completion of the baiting a contractor is employed to rip warrens in the scrub. Fumigation follows if warrens are re-opened.

Fox Control

Baiting programmes last about six weeks and are held in Spring and Autumn. The baits are placed in small mounds of sand. They are checked weekly and replaced if necessary. Each bait station is numbered and activity at each station is recorded.

Feral Cats

Last year we became aware of the presence of feral cats in the area and purchased cage traps. To date about 10 cats have been caught.

The ten farmers involved in the Mantung Land Management Group are determined to continue the project for as long as malleefowl survive in the area.

Community Malleefowl Conservation in Victoria

Archie Vann

Malleefowl Preservation Society, Victoria

This presentation will describe the activities of the Malleefowl Preservation Group in Western Victoria. The role of volunteer groups in ground surveys of malleefowl mounds, mound monitoring, predator control and research including the collection of road-kills for DNA analysis will be discussed.

Conservation and Evolutionary Genetics of the Malleefowl

Stephen Donnellan & Ralph Foster

Evolutionary Biology Unit, South Australian Museum
ph (08) 207 7479, fax (08) 207 7222

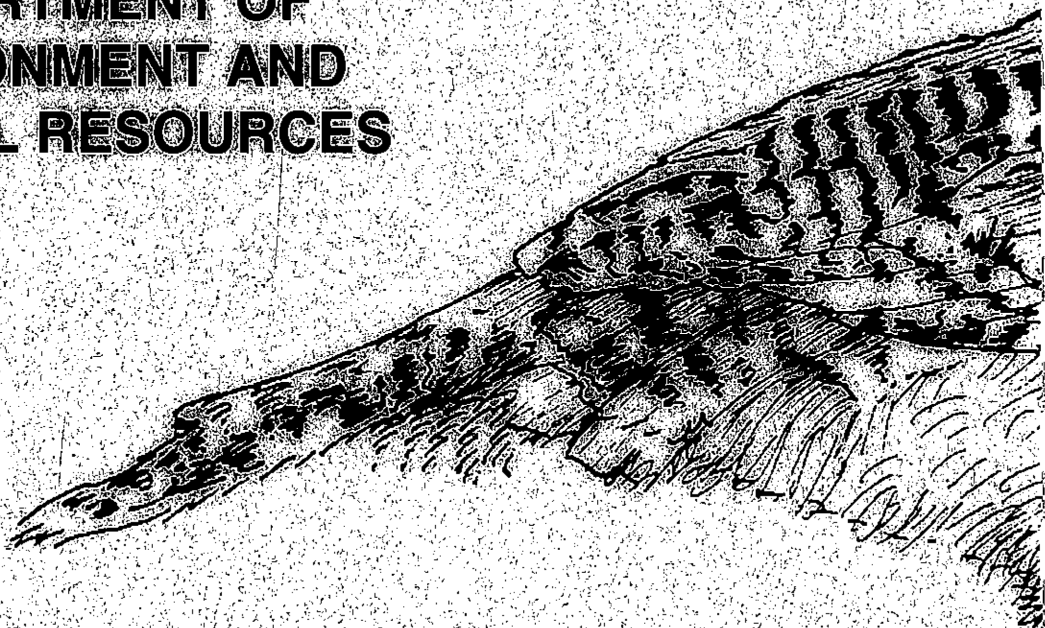
We are conducting a survey of genetic variation in remnant populations of the Malleefowl across its range in southern Australia. The study aims to document the geographic distribution of any genetic variation present in the species by using molecular genetic techniques. We will use allozyme electrophoresis to examine variation in proteins and nucleotide sequencing to examine variation in mitochondrial DNA and the nuclear genome. Initially, we will use the data to check the species level classification and to define regional management units. Later more detailed analysis will concentrate on particular populations and examine their breeding structure. These data will be used to assist in formulation of an overall management strategy for the species.

We have also examined the evolutionary relationships of the species with its relatives among the mound-building birds. The preliminary results will be presented.

WE NEED HELP - We would be grateful for any samples additional to those we have already collected as our samples up to now have been of a limited geographic scale. For the DNA analysis fresh feathers or pieces of tissue from dead birds (e.g. roadkills) can provide sufficient DNA for analysis. We will supply anyone wishing to assist with sampling with a tissue preservation kit. Samples can then be posted to the SA Museum, after suitable permits have been arranged with the State fauna authorities.

Chicago Zoological Society
Brookfield Zoo

DEPARTMENT OF ENVIRONMENT AND NATURAL RESOURCES



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