Managing Impacts of the Little Corella on the Fleurieu Peninsula

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1. Summary

The biology and behaviour of the Little Corella *Cacatua sanguinea* are described in the context of problems being experienced in certain towns on the Fleurieu Peninsula, South Australia. Possible options for managing bird problems are described and their applicability on the Fleurieu Peninsula is discussed. Recommendations are made for a possible management approach to reduce problems caused by Little Corellas in Strathalbyn and Old Noarlunga.

2. Background

The range of the Little Corella in South Australia has expanded substantially southwards since the 1920s (DEH 2007). According to Tony from ONCARA, the first flock of 20-30 birds was seen around 1990 in Old Noarlunga. Since that time the numbers have steadily increased until now there are many thousands that roost in the Onkaparinga Gorge at night, and loaf in trees in town during the day. I observed large flocks roosting and loafing at Old Noarlunga and Strathalbyn. Smaller numbers were noted at Mt Barker (with Sulphur-crested Cockatoos), Victor Harbour, Aldinga, Yankalilla and Goolwa. Their presence in these towns (but principally Strathalbyn and Old Noarlunga) leads to a number of problems related to their numbers. These problems vary in their significance depending on the attitudes of the observers. Chief among these problems is that of noise. While the corellas can be quiet at times while roosting at night, and while loafing during the day, they will periodically start calling en masse and may fly about, calling. Noise levels can be very high (see below). As the birds leave their roosts at first light, calling reaches a crescendo and wakens many residents not already awake.

It is relevant here to discuss the concept of Wildlife Acceptance Capacity (WAC). WAC is a measure of the tolerance of a person to a particular species of wildlife or situation where wildlife is present. A person's WAC is based on their personal values, attitudes, background and understanding of the nature of a given situation (Decker and Purdy 1988). For this reason, some people will regard Little Corellas as a pest, while others may have an entirely different view. All these views are equally valid, but they highlight the difficulty of reaching consensus on whether, and what, actions should be taken to manage what some perceive to be a problem.

The Department for Environment and Heritage (DEH), City of Onkaparinga and Alexandrina Council have searched for practical, cost-effective and responsible solutions to the problems for over 10 years. In 2002/3 QED Pty Ltd undertook a Corella Research Project on the Fleurieu Peninsula investigating the problems being caused by Little Corellas on the Fleurieu Peninsula, community attitudes, methods used to reduce problems and made

a number of recommendations for management and further study (QED 2003). Since that time, many sources suggest that corella numbers have increased and the problems have escalated. There have been many attempts to manage problems at a local level, but these have been piecemeal and of limited, or short-term, effect.

Little Corellas are highly intelligent birds and it is likely that one of their motivations for roosting in towns is that they feel safer there than in rural areas, where many landowners will shoot them. Indeed it was suggested to me that the Old Noarlunga corellas could not be pushed too far up the Onkaparinga Gorge because once they came within sight of the farmer up the gorge, he would shoot them. Old Noarlunga then, becomes their refuge from shooting. It is highly likely that a similar situation applies at Strathalbyn.

A number of residents in Old Noarlunga expressed the view to me that the corellas displace other native species from the town, and that they occupy nest hollows to the exclusion of other species, which are threatened by this competition. I was told that ravens and honeyeaters were no longer in town and that they had been driven out (or excluded somehow) by the corellas. In fact, both White-plumed Honeyeaters and ravens were present in Old Noarlunga, as were Nankeen Night Herons, in spite of the large numbers of corellas. I think one of the reasons for the above belief is that the noise and visible presence of the corellas draws attention away from the other species.

Little Corellas nest principally in hollows in living or dead eucalypts, as do many other native bird species, particularly members of the parrot family. Large parrots, such as the Yellow-tailed Black-Cockatoo, Long-billed Corella, Sulphur-crested Cockatoo and Galah on the Fleurieu Peninsula, and the Glossy Black Cockatoo on Kangaroo Island, use similar large hollows as the Little Corella. With the exception of the Glossy Black Cockatoo, all of these species are common and widespread and possible competition for hollows by the Little Corella is unlikely to be a problem. Most other parrots use hollows with smaller entrances than are used by corellas and it is not uncommon to see several different species of birds using hollows in the same tree that corellas are nesting in (pers. obs.). It is most unlikely that the expansion of the range of the Little Corella into the Fleurieu Peninsula and its possible extensive breeding there will affect hollow use by other native species.

It is important to keep in mind that while the discussion below focuses on Little Corellas, Long-billed Corellas are also present in small numbers in Old Noarlunga and Strathalbyn and contribute to the problems being experienced. Their behaviour, breeding and diet are very similar to those of the Little Corella. It is also possible that Long-billed Corella numbers are increasing on the Fleurieu Peninsula but more data are required before this can be confirmed.

2.1 Legal status of the Little Corella

In South Australia, by default native bird species are protected under the **National Parks and Wildlife Act 1972** and may be destroyed under the conditions of a destruction permit issued where birds are causing economic and/or environmental damage. A destruction permit is not required for species declared unprotected under Schedule 10 of the Act. This includes the Little Corella and permits landowners and shooters acting on their behalf to shoot Little Corellas on that land. In addition, shooters authorised by and acting on behalf of a Corporation or local Council may shoot Little Corellas on land managed by the Corporation or Council (DEH 2007). A destruction permit is required for any lethal control of Long-billed Corellas and, for Little Corellas, where trapping and gassing is the control method.

3. Little Corella Ecology and Behaviour

3.1 Description

The Little Corella is one of 14 species of cockatoos in the subfamily Cacatuidae in Australia, which includes the cockatoos and Cockatiel *Nymphicus hollandicus*. The Little Corella is 350-400 mm in total length, weighs 430-580 gm, is white above and below, with an upright white crest raised when the bird is aroused. The undersides of the wings and tail have a yellow wash. The bill is light blue-grey to whitish and the large naked eye ring is blue. There is an area of pink to red on the lores, sometimes forming a band over the bill. The sexes are externally indistinguishable. The sub-species in South Australia is *Cacatua sanginea gymnopis* (Rowley 1997 [in DEH 2007], Higgins 1999). The Long-billed Corella is distinguished from the Little Corella by its very long and narrow upper mandible, shorter crest, brighter and more extensive red on the lores and extending behind the eye, and a reddish crescent on the lower neck.

3.2 Range and habitats of sub-species *gymnopis*.

The Little Corella is only one of several species that are expanding their range southwards in South Australia, others being the Crested Pigeon and Galah. The expansion of the Little Corella southwards has occurred since about 1920, when early records suggest that it was restricted to inland waterways in the far north east of the State. From the 1960s onwards, Little Corellas were recorded continuously and increasingly in the Flinders Ranges,

Mt Lofty Ranges and neighbouring areas and in small groups in summer in parts of the Fleurieu Peninsula. It was not until about 1990 that large flocks were first recorded at Old Noarlunga and Strathalbyn, where they have now become regular summer visitors. By 2001 Little Corellas were first observed in Port Noarlunga, Port Elliot and Christies Beach, indicating that the range, if not numbers, is continuing to expand (QED 2003, DEH 2007, Higgins 1999).

The subspecies *gymnopis* is found in a wide variety of environments, but always near permanent water. It is found on open plains, grassland, sedge plains, saltbush, savanna, arid woodlands; coastal mangroves; cultivated farmlands; rocky ranges; woodlands and mallee adjoining riverine vegetation. It is also now common in urban areas of Adelaide, Melbourne and Sydney and has been introduced to Perth, outside of its natural range (Higgins 1999). This broad range of habitats is reflected in its distribution covering most of inland eastern Australia south of the Barkly Tableland and the headwaters of the south east Gulf of Carpentaria Drainage. It extends as far west as the Western Australian border and SE South Australia and Wilsons Promontory in Victoria, in the south. There is a disjunct population in coastal and subcoastal Western Australia south of the Great Sandy Desert (Higgins 1999).

3.3 Diet of the Little Corella

There is little doubt that clearing, the provision of water and the extension of grain crops have benefited the Little Corella. The diet of most cockatoos is based on plant foods including a wide range of seeds, fruits, flowers, nuts, bulbs and corms, including the corms of the introduced Onion Grass *Romulea* spp, a prolific and widespread annual (Temby & Emison 1986, Higgins 1999). Cockatoos have learned that many commercial crops provide a good food source and cereal grains, sunflowers, apples (taken for their seeds), nuts and the seeds of pine trees are some of these. Most corella feeding activity involves foraging on the ground where much digging for bulbs takes place. Ploughed ground attracts corellas which feed on exposed bulbs and later on germinating cereal (wheat, oats, barley) seeds. Cereal crops may also be used as a food source when the grains are at the “milky” stage before ripening, and stubbles left after the crops are harvested attract large flocks of corellas seeking remnant grain. Little Corellas have also been observed feeding on dried grapes in vineyards on the Fleurieu Peninsula (C. Button, pers. comm.).

Temby and Emison (1986) reported that, in the Long-billed Corella, the diet over summer was almost entirely composed of cereal grains from stubble paddocks. Before the introduction of myxomatosis to control rabbits in the early 1950s, the immense numbers of rabbits would also have used this food source. This intense competition for food was probably a major factor limiting the corella population by reducing survival of young birds to extremely low levels. There is little doubt that access to remnant grain in stubbles since the introduction of myxomatosis reduced rabbit densities in the 1950s has enhanced the survival of fledglings and contributed to the increase of cockatoo populations (Emison et. al 1994).

3.4 Breeding

Little Corellas exhibit mate fidelity, probably for many years, although if a mate dies another is likely to be found by the next breeding season. Little Corellas nest in hollows in large old trees and in cliffs, where usually two or three eggs are laid in early spring. It is likely that a pair will use the same hollow year after year, and may visit the hollow periodically throughout the year as in the Long-billed Corella (pers. obs.).

Approximate incubation (about 24 days) and nestling (about 50 days) periods are known for the Long-billed Corella (ENRC 1995) and similar periods are likely in the Little Corella (DEH 2007). A newly-fledged Little Corella will spend at least two months with its parents as it learns to be self-sufficient.

Survival of young Little Corellas to breeding age is not known, but in a detailed study of the Galah in Western Australia, Rowley (1990) found that only 9% of Galahs that left the nest successfully survived to three years of age. Survival of Little Corellas to breeding age (probably three years) is likely to be equally low. Little Corellas live at least 50-60 years in captivity, but longevity in the wild is likely to be less than this.

It is not known where the Little Corellas that cause problems in towns on the Fleurieu Peninsula breed, but it is likely that they breed in some of the many large, old eucalypts that are abundant near Ashbourne and from Mt Barker towards Wistow, near Langhorne Creek, Macclesfield, in the hills to the east of Old Noarlunga and, further south, near Yankalilla. Other suitable trees are abundant near Currency Creek and north of Port Elliott and Victor Harbour.

Several pairs of corellas were seen sitting in excavated holes in the cliffs at Old Noarlunga (pers. obs.) and it is very likely that they breed in those holes.

It is probable that only some of the corellas of breeding age actually breed each year, but this proportion is not known; neither is it known whether access to breeding hollows is limiting. It would require detailed research with marked birds to determine these factors.

3.5 Activity patterns

The typical daily activity pattern for Little Corellas is to start calling at first light. As the light grows, birds begin to move about the roost trees and calling intensifies. Birds may fly to other trees, often with exposed or dead branches at the top, to catch the first sunlight and bask for a period. The birds then fly off to commence foraging in a sown crop, a pasture, stubble, or a roadside. The first bout of feeding lasts for a variable period, determined in part by temperature (Emison et al. 1994), abundance of food and whether there are young to feed, and can last from half an hour up to four or five hours. Little Corellas then usually return to a resting or loafing site to digest food, preen, play and rest. During summer, this resting period may last for a number of hours, until the day is cool enough for the birds to resume feeding late in the afternoon (if the weather is hot). In winter, feeding may continue throughout the day. Drinking generally occurs after the afternoon feeding bout, but birds may also drink at other times. Little Corellas return to the evening roost site near sunset, and are often noisy while settling to roost. On moonlit nights, Little Corellas often call and move about the roost site, flying to other trees on occasion.

In addition to daily activity patterns, there are seasonal activity patterns influenced both by food availability and breeding activities. When pairs are breeding, they are dispersed over the countryside, where they feed near their nest hollows. At this time of year (spring) corellas are mostly seen in pairs or small flocks.

After the young fledge (November usually) they join growing flocks that gather to feed in crop stubbles, slashed paddocks and other, concentrated food sources. At this time of year, the ground becomes increasingly hard and corellas rely more on surface seeds and less on digging for bulbs and corms (Temby and Emison 1986). This is when large flocks form, comprising young of the year, their parents and non-breeding birds. These summer aggregations of birds roost communally at traditional sites and tend also to feed in large groups at favourable food sources. Flocks “accumulate” at such sites by a process known as ‘local enhancement’, whereby birds flying past will change course to join other birds they can see on the ground, feeding. By

this means, very large aggregations of cockatoos can form where there is adequate food. The white colour of corellas and Sulphur-crested Cockatoos enables flying birds to see others feeding on the ground from at least one kilometre away and change course to join them (pers. obs.). Feeding in large groups also provides some safety in numbers against aerial or other predators.

It is not until the autumn break when significant rainfall softens the ground over a wide area, often in April or May that these flocks once again disperse into smaller groups for the winter and feed by digging in the now softer ground for bulbs and corms. By August, pairs have once again moved close to their nest hollows to feed and prepare for breeding.

4. Aspects of Little Corella behaviour that contribute to nuisance problems at Old Noarlunga and Strathalbyn

One noticeable feature of cockatoos is their beaks and the many ways in which they are used. Cockatoos use their beaks as a grasping tool, a chisel, pliers, and a digging implement and in combination with the tongue, a fine instrument capable of husking the seeds of dandelions.

As rodents gnaw objects to maintain their teeth, so cockatoos chew objects in their environment to maintain the beak in good condition, as it grows continuously. Furthermore, because cockatoos are highly social, vocal birds, gather in large flocks over summer, and roost both by day and at night in towns on the Fleurieu Peninsula, the potential for causing damage is obvious.

Cockatoos that spend time around towns may chew wires, removing the insulation and causing power failures. They may also damage aerials, pull out loose roofing nails, perforate the plastic pipes of rooftop water heating systems, dig on ovals and artificial surfaces, uproot plants in gardens or snip off the flowers and prune the trees they roost in (DEH 2007, pers.obs., Figs 1 and 2). Aside from beak maintenance chewing, another possible reason for the destruction within the built environment is that the birds are intelligent and curious and investigate objects in their environment.

Figure 1. Norfolk Pines in Soldiers Memorial Park, Strathalbyn, damaged by Little Corellas, February 2010.

It has been shown that another large parrot, the Kea *Nestor notabilis* of New Zealand, will investigate everything in its environment, often testing and manipulating objects with the beak. Keas are attracted to novel and unusual objects and if these objects can be manipulated the attraction is stronger (Grant 1993). Similar behaviour was noted in Old Noarlunga when a lighting system was installed in trees in Market Square. Corellas soon set to work demolishing the wiring – because they could. A similar fate followed installation of an electronic bird scaring device (C. Button, City of Onkaparinga, pers. comm.).

Little Corellas, like other cockatoos, are highly vocal and communicate loudly and frequently. When in large flocks, the noise can be very significant and may exceed World Health Organisation guidelines to avoid sleep disturbance and annoyance (DEH 2007) particularly when the birds are disturbed or aroused and flying. The disturbance may be caused by birds of prey flying past, deliberate harassment by people, or simply a consequence of normal social interactions. In towns, this noise may be distracting or upsetting for

some residents and, along with tree damage, was cited as one of the two most significant problems caused by Little Corellas in both Strathalbyn and Old Noarlunga (QED 2003).

Figure 2. Glass dome on shopping centre at Seaford, with Little Corellas picking at rubber seals between the glass panels, February 2010.

The presence of corellas in these towns clearly does not upset everybody. Chris Button (City of Onkaparinga, pers. comm.) believed that about half of the residents of Old Noarlunga were in favour of corellas being in town, with the other half wanting them gone. Figures 3 and 4 illustrate that some people are well-disposed towards the corellas, or at least see an opportunity in the fact that they are present in large numbers.

This highlights one of the major challenges for management authorities: how to address what some see as substantial problems without alienating the rest of the community. Is it possible in this situation to reach a consensus? Is consensus required, or do management authorities (DEH, Councils, Adelaide and Mt Lofty NRM Board, Police) agree on strategies required, communicate them to the communities and implement them?

Figure 3. Not all residents of Strathalbyn are opposed to the presence of corellas, February 2010.

5. Options for managing Little Corellas and their applicability on the Fleurieu Peninsula.

5.1 Bird damage control principles

Bird damage and bird damage controls are thought to have occurred since crops were first grown. Indeed, the long history of human interaction with birds has been characterised by the use of damage control techniques that remain familiar today. Shooting, scaring, repellency, exclusion, scarecrows, bounties, and overplanting in order to provide sufficient harvest despite feeding birds have for centuries been used as measures to combat bird damage. In 1424 King James 1 of Scotland introduced an Act for the

Figure 4. In Old Noarlunga, corellas have been seen as a marketing opportunity.

destruction of Rooks *Corvus frugilegus*. In 1668, a book by Gervase Markham included a chapter on techniques and suggestions for minimising bird damage to crops and orchards. Today's farmers and wildlife managers have therefore inherited a range of techniques that, while now more sophisticated, remain little different in intent and method from those of centuries past.

This long experience has not, however, identified a fool-proof method of bird damage control, apart from total exclusion.

5.2 A strategic approach

Best practice bird management, as defined by Tracey et al. (2007), involves four activities:

- Define the problem;
- Develop a management plan
- Implement the plan;
- Monitor and evaluate the results

While this approach was directed at managing bird damage to horticulture, the principles apply generally to bird damage or nuisance problems of many kinds. This approach will be recommended following discussion below of the possible options for managing damage caused by corellas on the Fleurieu Peninsula.

Bird damage control measures include environmental management; scaring; chemical controls including deterrents, poisons and humane capture through the use of chemical agents; tactile deterrents; behavioural manipulation; exclusion; shooting; trapping; fertility control and egg destruction. Appendix 1 shows these options in a Feasibility/Acceptability criteria matrix.

5.3 Environmental management

Environmental management involves manipulating the environment to make it unsuitable for the corellas in some way. This could involve such actions as removing food or water sources, or removing roost sites. None of these actions is feasible in the context of corellas on the Fleurieu Peninsula.

Food sources are many and dispersed over a large area. That said, there is still merit in removing such food sources as spilt grain around the silos in Strathalbyn, as this creates a local attraction for corellas and Rock Doves (feral pigeons). However, the corellas are not likely to be affected significantly by removal of this food source and from my observations; there are many other food sources (crop stubbles, slashed paddocks, Aleppo Pines etc.) within easy reach of the birds that roost in Strathalbyn. Few of these food sources can be managed effectively to prevent feeding by corellas.

Similarly, corellas have access to water from a wide range of natural and artificial sources, many of which cannot be made unavailable to the birds. Finally, removing the roost trees would cause the corellas to go elsewhere, but would fundamentally change the nature of the towns of Old Noarlunga and Strathalbyn and would never be seriously contemplated.

5.4 Scaring methods

Scaring involves the use of various means to encourage or frighten birds to go elsewhere, usually by evoking a neophobic response. The effectiveness of scaring strategies depends upon a number of common factors, including persistence, integrating different scaring stimuli to maintain novelty and

variety to reduce habituation, and timing the scaring strategy to coincide with the arrival of the birds causing the damage, rather than waiting until a habitual pattern of behaviour has developed. One caution with this approach is that the birds are going to go somewhere, if the scaring is effective, and there is no guarantee that the problems will not simply be relocated.

5.4.1 Noise makers and scaring sounds

The mechanisms by which auditory devices are supposed to repel birds include pain, fear, communication 'jamming', disorientation, internal thermal effects, biosonics (taped alarm or distress calls) or electronic mimics of these, and ultrasound (Bomford and O'Brien 1990). Most of the sounds are generated by mechanical, electronic or explosive devices that include sirens, bangers, crackers and hooters.

Audible sound above 130 dB and infrasonic or ultrasonic sound above 140 dB causes pain and sometimes sickness in vertebrates. The range over which birds hear sound is similar to that of humans and it is therefore unlikely that birds can hear much ultrasound. An ultrasonic device called the Hi-tec Electronic Scarecrow was sold in Australia as a 'proven deterrent for diverting most land and flying creatures' according to accompanying literature. In careful tests of this device on the feeding behaviour of Starlings *Sturnus vulgaris*, where food was set out in segments with and without exposure to the device, no effects on Starling numbers or food removed were observed (Bomford 1990).

Some electronic noise-generating devices are claimed to produce sounds that simulate alarm or distress calls of various species. However, considering the intricacies of birds' vocalisations, any scaring response these synthesised calls achieve is likely to be due to the sounds being little more than something new in the birds' environment, and therefore of only short-term effect if any, before they are ignored by the birds, even if they remain irritating to people. A good example of this is a BirdXPeller purchased for $18, 000 to deter corellas in Strathalbyn. This device produced a synthetic, high-pitched oscillating sound that the corellas ignored, but was so obnoxious to the locals that persons unknown threw the device into the river (D. Mullins, Alexandrina Council, pers. comm.)!

Very loud and high intensity sound under experimental conditions has been shown to cause internal thermal effects but this is not a feasible control

method in practice. At pain-inducing intensities sound is likely to be a nuisance to people, be expensive to produce and conflict with animal welfare considerations. So-called 'white noise' has been used to confuse birds (eg Silvereyes *Zosterops lateralis*) that vocalise to maintain group cohesion during feeding.

5.4.1.1 Bioacoustic sounds

Bioacoustic sounds include distress, alarm and feeding calls that are recorded, amplified and broadcast over crops or other situations to scare birds. Many calls are species-specific and it is difficult to learn and record the right call. For example, distress calls of the Galah *Cacatua roseicapilla* attract, rather than repel, other Galahs (Jaremovic 1990), while alarm calls of the Sulphur-crested Cockatoo elicit a fleeing response (personal observations), and it is highly likely that Little Corella alarm calls would have the same effect on this species.

There appears to be some convergence between species in the general characteristics of alarm calls such that calls by one species may alert other species. In Australia, there appear to be sentinel species such as Noisy Miners *Manorina melanocephala* whose alarm calls alert not only other bird species but rabbits as well (de la Motte 1990, personal observations).

An improvement on just playing recorded alarm or distress calls at set intervals is to have a device that can be triggered to play only when birds enter the area to be protected. This should increase the time before habituation occurs. If a range of different calls are played at random, then habituation is likely to take even longer, provided the calls are biologically significant, and are only played for short periods.

Advantages of bioacoustic sounds
Can be a useful component of a scaring strategy when used appropriately. Likely to be accepted by many as a benign, non-lethal means of deterring corellas.

Disadvantages of bioacoustic sounds
Subject to habituation if used in isolation and played repeatedly at frequent intervals. Adds to the noise already created by the corellas.

5.4.1.2 Gas guns

Gas-operated scare guns (gas guns) come in a variety of models, producing a single, double or triple bang and are able to be set to go off at either random or fixed intervals. Some models swivel to face a different direction following each blast. The sound produced is somewhat like the sound of a shotgun. Scare guns can be useful to protect crops when used as part of an integrated scaring strategy that involves "positive reinforcement" (actual shooting of some birds) and may be used in other situations. As with most noise-making devices, corellas may become accustomed to them if they realise there is no danger associated with the noise (hence the need for positive reinforcement).

Advantages of gas guns
Can be a useful component of a scaring strategy when used appropriately and reinforced with some real shooting.

Disadvantages of gas guns
Subject to habituation if used in isolation and operated repeatedly at frequent intervals unless supported by some real shooting. May continue to operate even when birds not present or nearby. Adds to the noise already created by the corellas. Unlikely to be accepted by townspeople and may alarm tourists.

5.4.1.3 Bird Frite® cartridges

Cracker cartridges (Bird Frite® cartridges) are explosive projectiles fired from a 12 gauge shotgun. They are designed to explode about 80 m from the shooter and can be directed to explode over or within a flock of birds. The loud report emitted does scare birds, but habituation will occur unless these devices are combined with recorded alarm or distress calls or other scaring measures and some shooting.

Advantages of cracker cartridges
Can be a useful component of a scaring strategy when used appropriately and reinforced with some real shooting. Can be used more strategically than gas guns, since they are operated by a person and can be directed where and when needed for greatest impact.

Disadvantages of cracker cartridges

Subject to habituation if used in isolation. Adds to the noise already created by the corellas. The loud reports will alarm some residents and tourists, may scare dogs and cause many dogs to bark. Bird Frite® cartridges are expensive and currently cost $5.00 each.

5.4.2 Visual deterrents

5.4.2.1 Objects

The use of visual deterrents is undoubtedly one of the oldest bird scaring methods. Human activity in the crop is perhaps the simplest form of this and has been employed since at least 10 000 BC and the first growing of crops.

Since that time, a great range of devices have been used. Many of these, or their modern equivalents, are still employed today. Scarecrows; dead birds hung or spread on the ground; plastic bags; wine cask inners; balloons displaying big eyes; reflective tapes and mirrors; humming tapes; real birds of prey; plastic bird of prey; silhouettes or kites; model and real aircraft; and motor vehicles, are all used to enhance the scaring of birds.

Many of these devices or techniques can be of use as part of an integrated damage management program. If there is no real threat present, however, the problem of habituation to most stimuli remains.

The combination of methods, such as eye-spot balloons with hawk kites attached, often yields longer-lasting effects than either method on its own. Furthermore, the responses of different bird species vary, with some species habituating very quickly, while others remain wary for many days or weeks.

Tests by the Agriculture Protection Board of Western Australia of a variety of visual devices in fruit crops failed to demonstrate any significant effect against parrots. Numbers of birds and damage levels did not change (Mawson & Long 1990). Corellas used to the sights and sounds of urban areas are unlikely to be concerned about new visual devices deployed near their roosts, quite apart from the negative aesthetic aspect of such devices.

Advantages of visual deterrents
Benign, low cost, quiet and unlikely to upset residents. Unlikely to deter desirable bird species because of habituation.

Disadvantages of visual deterrents
Of little use unless as dynamic component of an integrated scaring strategy, since rapid habituation is likely.

5.4.2.2 Movement

Movement enhances the effectiveness of scarecrows and other visual devices. Thus an animated crow-killing owl model was more effective at protecting vegetables from crows than the owl alone or dead crows (Conover 1985). Human-shaped scarecrows that shake their heads and slowly wave their arms up and down are reported to be effective. A variation on this theme is a model man with a gun that pops up periodically from the undergrowth with a loud bang, and is also reported to be reasonably effective (Crocker 1984).

Advantages of movement-enhanced visual deterrents
Benign, relatively low cost, quiet and unlikely to upset residents. Could be used as a component of an integrated scaring strategy. Able to be improvised from available devices (eg eye-spot balloons).

Disadvantages of movement-enhanced visual deterrents
Not readily available in Australia. Corellas may become habituated rapidly unless the devices are used sparingly and in concert with other scaring stimuli.

5.4.2.3 Birds of prey

Trained birds of prey have been used successfully at a number of airfields in Europe, Britain and North America, usually in some combination with cracker cartridges, distress calls and shooting. Gulls were one of the main target species, but several others were also successfully deterred. Factors such as cost; availability; inability to fly at night; while moulting; during strong winds, rain or fog; the requirement for trained handlers; hazard to aircraft caused by the birds of prey themselves, and access to several trained birds have curtailed the use of these birds in most situations.

Trained falcons, particularly Peregrine Falcons *Falco peregrinus*, have been used at Mascot Airport in Sydney to control Silver Gulls *Larus novaehollandiae*. This project was abandoned because of excessive costs and limited effectiveness. Trained birds of prey are not relied upon to protect

crops in Canada, the USA or the UK, where falconry is legal, because of cost and lack of effectiveness (I. Temby, personal communications during Churchill Fellowship tour, 1999; Tracey et al. 2007).

Use of tame raptors can deter corellas from a limited area while the raptors are present. This is not inconsistent with a natural situation: when raptors appear, the corellas give alarm calls, fly to trees or mob the predator and keep calling until the raptor flies away. Under natural circumstances this usually takes a matter of a few minutes after which the corellas resume their activities (pers. obs.). The difference with trained raptors is that the handler can keep his birds present for several hours at a time, and therefore deter the corellas for longer than would occur under natural circumstances.

Advantages of using trained birds of prey
This appears to be a benign, “natural” solution to the problems caused by corellas and has much appeal for some members of the public.

Disadvantages of using trained birds of prey
Highly expensive and of limited effect in both space and time. May appear to drive corellas from an area but has little residual effect and cannot remove corellas from, say, the whole of Strathalbyn.

5.5 Chemical controls

5.5.1 Bird deterrent chemicals

Most bird deterrent chemicals rely on the chemical being applied to a food and ingested, where they may cause primary repellency because of their unpleasant smell or taste, or because they cause pain or irritation. Secondary repellency to ingested chemicals results from the chemical making the birds feel ill, resulting in a conditioned aversion to that chemical and/or the food with which it is treated.

In a series of trials of various chemical treatments of cedar frames placed in the cockatoo aviary at Healesville Sanctuary, there was no difference in the time to destruction between frames treated with proprietary chemical bird deterrents, frames treated with hot English mustard, hospital strength disinfectant, methyl anthranilate (a human food flavouring additive that occurs naturally in many plants and that was known to deter birds from eating treated seed – see below), and those treated with water as a control. The conclusion

was that these chemicals were not deterring the birds because they were not ingesting the timber, just biting pieces off (I. Temby, personal data).

None of the repellents designed to deter birds from eating things are likely to be of any use against corellas pruning trees in towns on the Fleurieu Peninsula, since they are not ingesting anything, merely biting or chewing for beak maintenance and/or amusement.

An alternative means of delivering a methyl anthranilate product (registered in the USA as Rejex It Fog Force) to birds is as an aerosol generated by a fogging machine, or from a pressure pack. When birds are exposed to the aerosol, it irritates the mucous membranes of the eyes and nose, and can be an effective means of preventing birds from using a site. Several applications of the aerosol may be required before the birds learn to avoid the site. Relatively calm conditions are required so that the aerosol can be directed where required. This product is not yet registered for commercial use in Australia.

5.5.2 Ingested poisons

In many countries the use of chemicals to kill birds is illegal or may only be undertaken under Government authority. Few chemicals have been developed specifically for use as bird killing agents (avicides). Many agricultural chemicals such as insecticides are lethal to birds, and have been used illegally to destroy birds. This may result in significant numbers of non-target species being destroyed, as was observed in 15 cases in Victoria in which prosecutions resulted (Du Guesclin et al. 1983).

Various chemical methods have been used to reduce bird numbers in other parts of the world. These include DRC 1339, Avitrol, surfactants, toxic perches and alpha-chloralose.

DRC 1339, or starlicide, was developed specifically as a bird poison in the USA. It is not registered for use on cockatoos in Australia and is not considered appropriate for this purpose.

Avitrol is registered in Australia for use on Silver Gulls, and for the control of some exotic species under the proprietary name 'Scatterbird'. Its mode of action is to cause distress behaviour and erratic flight in affected birds, which then scares off the flock. Affected birds usually die. It is not regarded as

humane, and is not registered for use on corellas or other native birds for this reason, and is therefore unavailable for use on the Fleurieu Peninsula.

5.5.3 Toxic perches

Toxic perches provide another avenue for the destruction of birds. With this technique, perching areas inside buildings are coated with a grease containing the active ingredient fenthion (the products Avigel, Avigrease and Control-a-bird) which is absorbed through the skin of the birds' feet. While this method is registered for use in Australia against sparrows, starlings and feral pigeons in some States, there are serious secondary poisoning hazards to anything that eats the carcasses of birds poisoned this way, and it will affect any bird that lands on perches thus treated. The deaths of Peregrine Falcons *Falco peregrinus* in Melbourne recently were believed to be a consequence of eating feral pigeons affected by fenthion placed on their roost sites by a licensed pest controller in accordance with label instructions. Toxic perches are neither appropriate for outdoor situations nor for corella control.

5.5.4 Surfactants

A further chemical approach to the destruction of birds has involved spraying birds that roost communally with a surfactant (wetting agent), usually during cold or wet weather, resulting in the birds dying of hypothermia. This method has been used in the USA, France and various African countries, but would be unlikely to be approved for use in Australia because of animal welfare concerns.

5.5.5 Alpha-chloralose

Alpha-chloralose is a narcotic agent that, depending upon the dose administered, is used for the capture or destruction of birds. An advantage of the use of this substance is that it provides the opportunity for non-target species to be revived. However, it can take a considerable time until the onset of narcosis and sufficient immobilisation to enable capture. This may be 20-50 minutes in the Feral Pigeon, 20-25 minutes in House Sparrows *Passer domesticus* and Rooks *Corvus frugilegus*, 12-60 minutes in the Little Corella and 15-30 minutes in Silver Gulls (ENRC 1995, I. Temby unpublished data). An overdose may be administered for lethal control, or a lower dose sufficient to capture birds may be used. The Department of Sustainability and Environment in Victoria permits the use of alpha-chloralose for the destruction of Silver Gulls and Little Ravens *Corvus mellori*, where the bait medium is margarine spread on bread, and is readily consumed by those birds. There is

some evidence that cockatoos may be reluctant to eat seeds coated with alpha-chloralose (they are unlikely to eat bread) and it is difficult to ensure a sufficient dose to immobilise birds when grain is treated, if the birds do not ingest the bait readily. Alpha chloralose has also been administered to Little Corellas in water (B. St. John, pers. comm.), where it led to a localised, short-term reduction in corella numbers and pruning damage to trees, but is now not permitted as a management technique in South Australia (DEH 2007).

5.6 Tactile deterrents

Non-toxic sticky polybutene gels are available for application to ledges and other sites where birds perch. Birds do not like perching on the soft material and avoid the surface where it has been applied. Such gels are used on buildings, mostly for control of Feral Pigeons *Columba livia* and Starlings. Use of these gels can be problematic, as small birds such as Welcome Swallows *Hirundo neoxena* can become trapped, creating an animal welfare and public relations problem. Irrespective of the potential problems for small birds associated with use of this product, it is not registered or practical for use on roosting trees.

5.7 Decoy models

For some species of birds, manipulation of their own behaviour can be an effective way of attracting or repelling them. Many birds have an alert posture or other visual signal to indicate to other birds that there may be danger about. Brent Geese *Branta bernicla* stretch their necks upwards and shake their heads before flying off. Dummy geese mimicking this posture were effective in deterring most incoming flocks from landing nearby (Crocker 1984).

Woodpigeons *Columba palumbus* in England are a serious crop pest. These birds have distinctive white wing bars, visible only when they take flight. It has been shown that models of pairs of outstretched wings are sufficient to stop other Woodpigeons from landing, and that this effect can last over a 9-week period (Inglis & Isaacson 1987). A combination of models of spread Black Swan *Cygnus atratus* wings, showing their white wing bars, and alarm calls, was an effective strategy to reduce damage by swans to pastures at Werribee (ENRC 1995).

The use of decoy (model) ducks to attract wild ducks close to shooters is well known. Long-billed Corellas *Cacatua tenuirostris* are attracted to the sight of

other white cockatoos feeding and will change course to join them (Emison et al. 1994). During research on the Little Corella *Cacatua sanguinea* in the Flinders Ranges, it was shown that dead Little Corellas were useful as decoys to attract other corellas to a water trough (St John in ENRC 1995).

When alarmed, cockatoos feeding on the ground assume an alert posture, in which all birds stand erect just before flying off. Model Little Corellas set out in this alert posture in a sown crop may be effective at deterring other birds from landing in the vicinity, rather than attracting them. Conversely, model corellas in feeding posture may be effective at attracting other birds to join them at decoy feeding or trapping sites, for example. This strategy, however, has no applicability for deterring roosting corellas from towns.

5.8 Lethal control to reduce populations

Many people believe that killing birds that cause problems is the obvious solution. In reality, killing birds is time consuming, relatively ineffective and likely to attract adverse publicity (DEH 2007, ENRC 1995). There is also a real danger that attention will be focussed on improving the means of killing birds, and on achieving a high tally, rather than on focussing on methods that reduce the problems being caused.

5.8.1 Shooting

Shooting is commonly used and recommended as part of a scaring program, reinforcing the scaring stimuli of non-lethal controls by injecting real danger. Shooting, including shooting at night, may be an effective way to manage or eliminate a small, localised flock of birds. Shooting is, however, inappropriate in built up areas other than in exceptional circumstances. Furthermore, shooting is not an effective means of controlling large flocks of cockatoos (DEH 2007). On the other hand, since corellas (and other cockatoos) are long-lived, intelligent birds, it is likely that they will remember and avoid sites where there has been concerted shooting.

Chris Button (City of Onkaparinga pers. comm.) told me that concerted shooting of corellas in Willunga and Aldinga resulted in the birds avoiding those areas almost totally. This option is probably not available (acceptable) for Strathalbyn and Old Noarlunga.

5.8.2 Trapping and gassing

There is a perception that trapping and euthanasia of cockatoos is a simple and quick method for resolving a problem. In practice, trapping and euthanasia of birds is time consuming and requires that the birds be attracted to the trapping site, usually with food. The focus of trapping and euthanasia is on number reduction. Trapping and euthanasia will have no direct impact on problems being caused by the birds, since it is undertaken away from where the problems are being caused. The exception to this is where most of the birds causing the problems are destroyed and this is seldom possible. The experience of Victoria in this respect is instructive. Over a five-year period, Victorian taxpayers sponsored the trapping and gassing of 100 000 cockatoos (mostly Long-billed Corellas, but also Sulphur-crested Cockatoos and Galahs), at a cost of over $1 million. This was to reduce alleged damage caused by these birds to cereal crops and to infrastructure. Trapping teams became skilled at trapping and killing birds, but no data were collected on whether there was any reduction in damage or on impacts on populations. The program was described as effective by participants, because growers knew birds were being killed, but it was not possible to demonstrate any real reduction in damage, ostensibly the reason for the program.

A further factor that would reduce the impact of a trapping and gassing program is the possibility that the trapping may catch mostly immature birds – the very ones least likely to reach breeding age. In this case, trapping and gassing is likely to have little impact on the breeding rate of the population and may simply be removing birds likely to die anyway.

5.8.2.1 Trapping and human health

There is a human health risk involved in trapping and handling wild birds. Wild, apparently healthy birds can be symptomless carriers of the disease ornithosis (also called psittacosis), a potentially dangerous respiratory disease in humans, caused by the bacterium *Chlamydophila psittaci*. In birds, inhalation of the bacteria favours the development of acute infections, whereas ingestion of bacteria leads to latent infections (Burkhart & Page 1971). Infection in humans trapping and handling cockatoos is most likely to be through inhalation of feather dust or respiratory droplets.

If wild birds are being handled, masks should be worn to inhibit the inhalation of feather dust, and clothes and hands should be washed after contact with

these birds. Another potential source of this organism is via the dust from droppings under roost sites, stirred up particularly when mowing grass. It is not known how significant this risk may be.

5.9 Fertility control

Fertility control is regarded by some as an ideal technique of population control, since it does not rely on killing animals. However, this is not currently practical for free-ranging wild birds.

5.10 Destruction of eggs

Destruction of eggs is undertaken to control the numbers of some colonial birds, where nests are readily found and accessible, and where repeat visits can be made to destroy subsequent clutches of eggs laid in response to the initial visit. Little Corellas tend to disperse and nest over a wide area during their spring breeding season, usually in tree hollows. It is not practical to locate, let alone remove the eggs from the majority of nests of this species to prevent recruitment of young birds to the population.

5.11 Decoy food sources

There are many examples of the successful use of decoy or lure crops (crops grown or bought from farmers for the birds) and bait stations or feeding stations. Lure crops have been used in the USA for many years. In a trial of decoy feeding in South Australia in 1989, up to 4000 Long-billed Corellas were fed 20 tonnes of Oats over a ten-week period, while the main seeding and germination phase of winter cereals was completed. Taking into account the value of the grain, wages and on-costs, there was estimated to be a 10 to 15-fold benefit. This accounting did not consider the lower costs to farmers of the reduced scaring effort required at their crops or the extra time available for other tasks. (Alexander 1990).

This method can be a useful way of diverting birds from one food source to another, but is not a practical means of preventing corellas from roosting where they are not wanted.

5.12 Visual screens

Visual screens are barriers placed around a crop and as transects through it to block the birds' ability to see out of the crop and monitor the surroundings

for potential predators. Studies in New South Wales have shown that birds will concentrate their feeding in areas which provide the best position for surveying the approach of predators, chiefly birds of prey and humans.

Trials have demonstrated that by manipulating the visibility of feeding cockatoos, the normally highly palatable sunflower crops can be made unattractive to these birds (Allen 1990). Barb St John (pers. comm.) noted that Little Corellas would not drink from water troughs that had tall vegetation adjacent to the troughs, preventing the birds from having a clear view of the surrounding area. While screens could be erected around troughs that the birds drink at near Old Noarlunga, there are dams and the Onkaparinga River where the birds can also drink. Similarly, at Strathalbyn, there are many potential drinking sites not easily screened, so this method has limited application to the problems being caused at towns on the Fleurieu Peninsula.

5.13 Exclusion

Exclusion refers to the use of physical barriers to protect an area from access by birds. In a crop situation, this usually means some form of netting to separate the crop from the birds. On buildings, several kinds of devices can be placed on or over ledges and other potential perching sites to make them uncomfortable or unavailable to birds. These include spikes, wires stretched above the roost sites, 45^0 infills to create a sloping ledge instead of a horizontal one, netting and electric perching repellents. None of these (are) practical to prevent corellas from roosting in trees.

6. Best practice bird management of Little Corellas on the Fleurieu Peninsula

1. Define the problem

Large numbers of Little Corellas roost in towns on the Fleurieu Peninsula, particularly Old Noarlunga and Strathalbyn, and cause noise, tree damage, economic and other problems each summer, with the number of birds and length of problem period apparently increasing over time. Some of the problems are real (tree damage for example), while some are perceived (population doubles each year; birds produce four young). Perceived problems can be addressed by providing accurate information, while real problems (if deemed to be at unacceptable levels) require a range of actions as described below.

Stakeholders affected:

- residents (stress induced by frequent disturbance by noise from corellas, need to clean up mess created by corellas, loss of amenity and enjoyment of life, reduced house prices, disturbance from corella deterrent strategies);
- business operators (loss of trade because tourists stay away);
- tourists (loss of amenity caused by noise and mess from corellas and by disturbance from corella deterrent strategies);
- Councils (frequent complaints, demands for action, cost of implementing actions, purchase of bird deterrent devices, cleaning costs, arborist and consultant costs);
- Other agencies (DEH, NRM Boards), regulatory, advisory and funding functions.

Costs incurred – where possible, the impacts of the corellas need to be defined quantitatively so that meaningful targets for reducing these impacts can be set. Costs may include:

- Damage to trees (tree management eg pruning, maintenance and replacement costs);
- Loss of business (needs careful documentation);
- Reduced house prices (needs quantification and verification);
- Corella disturbance regime costs incurred by council - labour and materials;
- Council costs for cleaning;
- Sportsground maintenance costs resulting from corella impacts;
- Time costs – amount of time spent by people involved in corella monitoring and disturbance planning and actions and time spent being disturbed by corellas;
- DEH – time and resources devoted to addressing concerns about Little Corella impacts on the Fleurieu Peninsula.

2. Develop a management plan

There is no simple solution to reduce the problems associated with Little Corellas roosting in Strathalbyn and Old Noarlunga. Any successful strategy will be the result of agreement from the community, commitment to undertake and persist with the strategy until its goals are achieved, and the capacity and willingness to adapt or vary the strategy in response to unexpected responses from the corellas.

The first step is to gain consensus on whether there is a need to do anything. In both Strathalbyn and Old Noarlunga, there is a spectrum of views about the presence of corellas because everybody has a different Wildlife Acceptance Capacity and it may be difficult to gain consensus for this reason. The communities will need to know what is proposed before they can

consider whether they believe the benefits (fewer corellas, less noise and damage to trees) warrant the resources and disturbance of a control strategy.

It would be sensible to discuss the issues above and prepare a strategy, if that is the decision, so that it is ready to implement at the beginning of the next roosting season. This will eliminate the argument that more time is being wasted in further talk and planning. In fact, careful planning is essential, but this can be done before the season commences.

Define management objectives and performance criteria

It is important here to define targets quantitatively and have a date or elapsed time from initiation of actions to achieve the target (eg reduce early morning noise levels by corellas to a defined (acceptable) level in Market Square within two weeks of starting actions). Suggested targets could be:

- Prevent Little Corellas from establishing roosts in Strathalbyn/Old Noarlunga over the 2010/11 season, or;
- Keep number of corellas roosting in Strathalbyn/Old Noarlunga to no more than 500 birds over the 2010/11 season, or;
- Undertake scaring campaign that results in no more than 10 corellas using the riverbanks at Old Noarlunga each day, or;
- Ensure Little Corellas roost far enough up Onkaparinga Gorge that they are not audible from Old Noarlunga at night during the 2010/11 roosting season.

Note that if any corellas are allowed to remain in Old Noarlunga (or Strathalbyn), they will create an attraction for others. In reality, if large numbers of corellas are not wanted in one or both towns, then it must be understood that allowing some birds to remain will make it very difficult to regulate numbers at a desired level, if this level is not zero. Note also that it may not be feasible to allow corellas to roost in Onkaparinga Gorge at night but stop them creating early morning disturbance in Old Noarlunga or roosting in town during the day. In other words, if you wish to stop corellas using Old Noarlunga during part of the day, then they must be totally excluded.

Select an appropriate management option

Strategic targeted control (or Do nothing*)

3. Formulate and implement a management strategy

Communication is a vital part of the management strategy. Communication needs to be on several levels. Prepare a communications plan for the community and local media, clearly identifying the nature of the problem and

the reasons for the actions being used to resolve it. The implementation team must also have a communication strategy so that all participants are aware of the actions required and can react when directed during scaring operations. Implementation team members need to be debriefed at the end of each day's activities. Effective communication of successes and areas where methods need to be modified will help to maintain motivation and effectiveness of the strategy.

**"Do nothing" may be an appropriate response, if the proposed strategy for preventing corellas from entering the towns is deemed unacceptable for any reason.*

The strategy

If a strategy is chosen that aims to reduce corella numbers at Old Noarlunga and Strathalbyn, it would then be necessary to formulate integrated scaring campaigns using some shooting to reinforce the scaring methods, plus Bird Frite® cartridges, eye-spot balloons, broadcast alarm calls, flashing lights, spotlights. Scaring strategies need to be implemented as soon as the first flocks begin roosting in summer, to prevent the build-up to large numbers in either town. The scaring program may need to continue for some weeks. It is also important to monitor where the birds are diverted to, in case the alternative roosting site is equally unacceptable. Planning and preparation will include the need to:

- Obtain any required permits (DEH, EPA, Council) and police approval to shoot corellas in towns. It is important to remember that mixed flocks of both Little Corellas and Long-billed Corellas are likely to be present and these species have different permit requirements.
- Assemble materials for scaring birds (Bird Frite® cartridges, recorded alarm calls, spotlights, flashing lights on vehicles, eye-spot balloons)
- Train teams in use of scaring devices and have clear understanding of sequence of use (may need team of 10 people able to participate in scaring activities simultaneously in Old Noarlunga and perhaps 20 people in Strathalbyn). Teams should comprise interested and trained community members and be led by council employees familiar with organising and running a complex operation.
- Install lines and small pulleys in trees where corellas are likely to roost, to enable rapid raising of eye-spot balloons as required (and removal straight afterwards).
- Ensure residents are fully aware of the substantial disturbance that will be caused by the scaring program (particularly the noise of shooting and Bird Frite® cartridges). This is particularly important for elderly residents and hospital patients in Strathalbyn.
- Have trained counsellors/negotiators available in case residents require such assistance.

- Designate a media liaison person in each town to handle all media issues.

Suggested strategy and sequence for use of scaring devices

The underlying principle with a bird scaring strategy is to keep changing what you do, to keep the birds on edge and prevent habituation. Use an unpredictable sequence of devices, vary how they are used and adapt to counter changes in the behaviour of the birds.

The first action will be shooting of some of the first birds to arrive, to train others that there is real danger associated with humans. For this reason, shooting should be done from different sites, at different times and by different people. Some shooters should wear bright clothing and be obvioius; others dull clothing and discreet behaviour. Some shooting should be done from vehicles – not always the same ones, and some from a trail bike and some by people on foot. The aim is to shoot small numbers of birds and to introduce other scaring measures immediately after shooting has commenced. All shooting must be done in accordance with the Code of Practice for the Humane Destruction of Birds by Shooting and safe shooting principles.

Bird Frite® cartridges should be used sparingly and aimed to explode above roosting or flying flocks. Big-eye balloons should be raised rapidly where birds are roosting and alarm calls played while the balloons are being hoisted. They should be lowered again as soon as the corellas have taken fright and be covered as soon as they are back on the ground and stored out of sight of the birds. The birds need to be trained to avoid any humans in the towns, so cap guns or starter pistols could also be used by members of the scaring teams, but only for as long as the birds react with fear. Stop using them, or any other devices, once birds begin to lose their fear, and change to another device.

Sometimes, approach roosting birds without staring at them, but rather by feigning a total lack of interest, then when closer, suddenly look up and use the device (starter pistol, rubbish-bin lid, big-eye balloon, shotgun, etc). This will increase the birds' wariness, as they will find it difficult to tell when somebody is going to frighten them.

Alarm calls should be played briefly and always in conjunction with some other device (big-eye balloon, starter pistol, etc), that provides a logical context for the calls to be made.

Shooters, and others engaged in scaring, should sometimes use hides from which they can surprise the birds, and hides should be moved from place to

place, so that the birds are kept on edge. Shooting should only be used, after the initial training period, when birds begin to become used to some of the other scaring stimuli, to remind them and reinforce the message that there is real danger associated with the scaring program. Flashing lights and spotlights may need to be used in the program if the birds are still present at or after dusk, in combination with alarm calls and loud noises such as starter pistols.

At all times scaring teams need to be coordinated in their harassment of the birds by communicating where the birds are heading so that they cannot settle for any length of time. Intelligent use of scaring devices and methods to maintain variation and surprise will aid in deterring the corellas from roosting in town, but it may still take several weeks. During this time, there will be ongoing disturbance to the community and some community members will disagree with the program and argue for it to cease. For this reason, it is really important to have community understanding of what a scaring program will entail, and have its support, before the program commences.

4. Monitor and evaluate

There will need to be constant monitoring and evaluation of the reactions of the corellas to the management methods and the methods varied to maintain their frightening effects. At the same time, a detailed daily log must be kept of actions taken (times, materials, number of people), responses of corellas and whether targets are being achieved. This will enable a cost: benefit analysis to be undertaken.

Evaluation will give rise to one of the following possibilities (Tracey et al. 2007):

The management plan and its implementation were cost-effective and well implemented.
Action: continue with current strategy but consider whether control effort is appropriate and consider new control techniques if available.

T*he management plan was appropriate, but implementation was poor.*
Action: Define why implementation failed, rectify and re-apply plan.

The management plan was not cost-effective.
Action: Determine whether costs can be reduced (social, environmental, financial) or whether there are other or new approaches that can be implemented that might improve the cost: benefit of management.

5. Review management plan

The management plan must be reviewed at the end of the corella roosting season and a decision made about whether the benefits of the program warrant its costs (social, environmental and financial) in each town.

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Appendix 1. Feasibility/acceptability criteria matrix

Note that the feasibility of different management options or strategies may change over time, with changing public attitudes, additional information, or changed regulatory environment.

Control option	Feasibility/acceptability criteria						
	Technically possible	Will it work?	Practically feasible	Economically desirable (cost:benefit)	Environmentally acceptable	Politically/legally acceptable	Socially acceptable (local)
Environmental management	Yes	Yes	No	No	No	No	No
Noise makers including gas guns etc.	Yes	Sometimes, as part of strategy	Yes	?	Yes	Yes	?
Bioacoustic sounds	Yes	Sometimes, as part of strategy	Yes	Yes	Yes	Yes	?
Visual deterrents	Yes	Sometimes, as part of strategy	Yes	Yes	Yes	Yes	Yes
Birds of prey	Yes	Partly	No	No	Yes	Yes	Yes
Chemical deterrents	Yes (fogging)	Yes	No	?	Yes	No*	?
Poisons	Yes	?	?	?	No	No	No
Surfactants	Yes	?	No	?	No	No	No
Alpha chloralose	Yes	No	No	?	?	No	No
Tactile deterrents	Yes	?	No	No	No	No	No
Decoy models	Yes	No	No	No	Yes	Yes	Yes

Shooting	Yes	Sometimes, as part of strategy	Yes	Yes	Yes	?	?
Trap and gas	Yes	?	No	No	Yes	Yes	No
Fertility control	No	No	No	?	yes	Yes	Yes
Egg destruction	No	No	No	No	Yes	Yes	Yes
Decoy foods	Yes	No	No	No	Yes	Yes	Yes
Visual screens	No	No	No	No	?	?	?
Exclusion	No	No	No	No	?	?	?

*Fogging with methyl anthranilate is not currently registered for use in Australia