Little Corellas

SOCIAL AND ECOLOGICAL RESEARCH FOR MANAGEMENT IN SOUTH AUSTRALIA

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Discovery Circle

Scanlon, A., Roetman, P., Stead, M., Gray, S., Lethbridge, M. (2017) **Little Corellas: social and ecological research for management in South Australia**. Discovery Circle Initiative, University of South Australia, Adelaide.

Little corellas

Acknowledgements

The ***Little Corellas*** project has been run in South Australia by the **Discovery Circle** (www.discoverycircle.org.au), a citizen science initiative at the University of South Australia. We thank all the contributors to this project, in particular the members of the South Australian community who contributed time completing surveys, participating in workshops, and showing us around their towns during 2015 and 2016. The ***Little Corellas*** project was approved by the University of South Australia's Human Research Ethics Committee (34915) and Animal Ethics Committee (U22-15). The project was conducted with the support of:

- **University of South Australia**
- **Department of Environment, Water and Natural Resources**
- **Local Government Association of South Australia**

As well as six local government areas:

- **Alexandrina Council**
- **City of Marion**
- **City of Salisbury**
- **District Council of Mount Barker**
- **The Flinders Ranges Council**
- **Town of Gawler**

Project team

Discovery Circle, University of South Australia:

- **Dr Annette Scanlon** is an environmental scientist and works as a research assistant at the ***Discovery Circle*** at the University of South Australia. For this project, she was particularly involved in developing and conducting the social survey, Mental-Modeler workshops, field data collection, data analysis and contributed to project design. Annette also led the writing of this report.

- **Dr Philip Roetman** is the research leader of the ***Discovery Circle*** initiative; he is particularly interested in citizen science – actively involving the wider community in research projects. Philip was the overall project leader for the ***Little Corellas*** project and was particularly involved in developing the research design of the project as well as developing and conducting the social survey, Mental-Modeler workshops and data analysis, and he also contributed to the writing of this report.

- **Michael Stead** is an applied ecologist and professional scientist with experience and expertise relating to: ecological and mathematical modelling; pest and overabundant species management; survey and monitoring design; landscape ecology and restoration; aerial surveys. He was employed at the ***Discovery Circle*** to contribute to the ***Little Corellas*** project. Michael undertook the habitat modelling and wrote the habitat modelling section of this report.

Michigan State University and *Mental Modeler*:

- **Dr Steven Gray** is an Assistant Professor in the Department of Community Sustainability at Michigan State University and lead developer on the ***Mental Modeler*** software. Steven provided research planning support for designing the modelling workshops, including analysis of the models and scenario building.

Flinders University:

- **Dr Mark Lethbridge** has research interests in vegetation condition monitoring using field and remote sensing, optimization algorithms, decision support tools in production and natural resource management and ecological, movement and spatial modelling. Mark oversaw the habitat modelling and contributed to project design.

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Introduction

While many people enjoy seeing little corellas, large flocks in urban and rural areas cause considerable problems in the warmer months. The most common problems are damage to trees (defoliation), taking grain, and disturbing residents with loud vocalisations. These native birds can also damage buildings, particularly when they chew flashing or wiring, tarpaulins, wooden structures, cars and a variety of crops. There is significant public contention regarding the management of little corellas.

Managing little corellas can be difficult. Many local councils have a history of problems with little corellas, and they have invested significant resources into developing strategies for their management. Extensive experience and knowledge of little corellas exists within these individual agencies and in local communities, but little information sharing or coordination of activities occurs among groups.

The purpose of the Discovery Circle's ***Little Corellas*** project was to explore management issues in city and town areas around South Australia in partnership with state government, local government and local communities. For the ***Little Corellas*** project, we used a mixed-methods approach, including:

- A social survey (1,270 respondents)
- Nine community workshops
- Field surveys at 144 little corella sites
- Development of models for little corella habitat suitability and land use preferences
- Synthesis of data into a master model for little corella management in South Australia using ***Mental Modeler*** (http://www.mentalmodeler.org/)

Our approach recognised that social, environmental and regulatory factors are necessary considerations for effective management of wildlife (Kellert and Clark, 1991); where:

- *Social factors*: interactions between stakeholders and the values held by stakeholders should influence decision-makers
- *Environmental factors*: biological and ecological requirements of the wildlife should guide the entire process
- *Regulatory factors*: the legal (or policy) system in which managers are operating also guides the process. The need for a state-wide little corella management plan was identified before this project commenced; we collaborated with local and state governments to frame the approach to little corella management

What's in this report

This report contains the results of our research and provides practical tools and strategies for the management of little corellas in South Australia. We propose an integrated approach (involving multiple strategies and stakeholders) with long-, medium- and short-term foci, including:

- **Creating barriers to roosting and feeding resources** (including practical recommendations)
- **Creating barriers to water resources** (including practical recommendations)
- **Identifying and creating sacrificial sites** (including key considerations for site selection and creation)
- **Using Mental Modeler to understand and educate about the management of little corellas** (including management strategies and trade-offs, with examples)

This report also contains case studies that demonstrate the use of the actions we propose and the use of Mental Modeler in three different scenarios:

1. Aldinga
2. Hawker
3. Hewett Primary School

In this "Key results and recommendations" section we also summarise the results of our research and provide recommendations, based on our research, for a new Little Corella Management Plan for South Australia, to be developed by the Department of Environment, Water and Natural Resources (DEWNR).

Key results

1. Social factors

Social factors include community knowledge, community acceptance, and how communities work together; we found:

- Some form of little corella management is generally desired, and the development of a **state-wide management plan for little corellas was widely supported**
- **Few participants actually disliked little corellas**, but many did dislike their destructive behaviours (particularly to trees) and their noise
- **Contention exists about the types of management** that are effective and desirable
- **Some management strategies were supported** by survey respondents who place a high intrinsic value on little corellas, and by survey respondents who are concerned about the impact of little corellas (e.g. encouraging little corellas to alternate sites). Other strategies were **opposed by both groups** (e.g. removing tree roosts and "doing nothing"). Neutral responses were recorded for both **effective** (e.g. increasing shrubs, managing water assets) and **ineffective** (e.g. falconry) control measures. Support for some actions (e.g. lethal deterrents) increased in workshops when they were explained
- While some people have extensive experience and holistic views on the management of little corellas, **many members of the community are not aware of the complexities of little corella management**, the actions that are taking place, or the costs involved
- The ***Little Corellas*** project workshops were useful in both the collection and dissemination of information, enabling a focussed and fair discussion of participants' knowledge and ideas about the causes and management of little corellas problem sites. Workshops were also useful for increasing **tolerance** and **understanding** of the issues
- Participants indicated that the workshops helped them to understand the complexity of little corella management, how costly management could be, and changed their opinions about the desirability of living with little corellas (overall, a convergence of attitudes was most noticeable, some participants became **more accepting** of little corellas when they realised the complexities of management, while others became **more concerned** about little corellas when they realised the difficulties involved in their management)
- Considerable confusion and misuse of terms was observed in the workshops, indicating that some responses to the survey might have been different if respondents had **more understanding of the terminology** and complexities of little corella management
- The practicalities of little corella management are **frustrated by the absence of any organised way to share resources or knowledge, or coordinating responses** among agencies, and the efforts of some councils maybe undermined by the actions or inaction of others
- A number of people around the state have **extensive experience observing and managing little corellas** (their input was invaluable throughout the project). Extensive discussions about management options were focussed on:

- **Habitat management and modification** (to reduce the attractiveness of problem sites to little corellas)
- **Sacrificial sites** (selecting sites and increasing their attractiveness to little corellas)
- **Lethal deterrents** used to reinforce other controls (and minimising attempts to control the little corella population using lethal methods)

2. Environmental factors

Environmental factors include the biology and behaviour of the wildlife species and the landscape in which the species exists; our results included:

- **Over 2,300 little corella sites identified by the public** were mapped within the Adelaide metropolitan area, Mount Lofty and Fleurieu Peninsula region (including Kangaroo Island), along the River Murray, in the Upper and Lower South-East and Mid and Far North sites
- Habitat modelling indicated important resources for little corellas:
    - **At a state-wide level**: river red gums, irrigated green space and major creeks
    - **Around the Adelaide and the Mount Lofty Ranges**: irrigated green spaces and major creeks
- Conversely, our modelling indicated that **little corellas avoid bushland areas**
- Land use analysis indicated that **recreational, agricultural and residential land uses** were consistently the best predictors of little corella distribution – these areas provide abundant food and water resources
- **Field surveys supported the findings of the habitat modelling and land use analysis**. Sites where little corellas are reported typically included extensive irrigated exotic lawn areas, freely available water, open habitat (low tree density, often with pine trees), very few shrubs, and low site "nativeness". Sports ovals (often surrounded by Aleppo pines) were commonly cited as little corella sites

Recommendations

The environmental factors described above clearly demonstrate that we have developed ideal conditions for increases in the distribution and abundance of little corellas in South Australia. Little corellas thrive in the agricultural and urban landscapes that we have created. Little corellas were **not** abundant or problematic in most of the state 50 years ago. Now that these birds are abundant and problematic, **isolated management actions are ineffective**. The approach and culture of pest management practices in urban areas needs revision; proactive and coordinated activities should be ingrained in our approach to these problems, and our reliance on reactionary and isolated (often inefficient) controls needs to be reduced. Further, management that does not account for social factors will be problematic. Therefore, we recommend an **integrated management approach**, including **long-, medium- and short-term actions** that consider both environmental and social factors. Importantly, it is **necessary to focus on long-term actions first**, as these actions are key to reducing issues at little corella problem sites. Medium- and short-term actions may then be used to alleviate issues while long-term plans are actioned.

*While this report includes practical actions to alleviate problems with little corellas, our recommendations move the **focus away from controlling birds** (short-term impact only) and on to **landscape management to deter birds**, and to reduce their abundance in problem areas over the long-term.*

Long-term actions and considerations

Long-term actions include planning on a 10+ year timeframe, with actions to be commenced as soon as possible. Long-term actions and considerations include:

- A long-term guided approach to **threat abatement**, including proactive management, to minimise future impacts of current and **emerging** *urban-adapting* and *urban exploiting* species (see Glossary for their definitions)
- **Reducing the availability of food and water resources** to little corellas (or creating barriers to these resources), including:
    - **Removal of any unnecessary, open food or water storage** at and around problem sites (e.g. grain piles, water troughs, water tanks)
    - **Installing or planting barriers to water resources** at and around problem sites (e.g. install trough covers, increase bank height, increase vegetation around water resources to reduce direct access; increase vegetation or screening near water resources because little corellas prefer drinking at open locations)
    - **Installing or planting barriers to food resources** (e.g. cover grain piles, increase vegetation or screening around food resources as little corellas prefer feeding at open locations)
    - Note that the removal of tree roosts (i.e. removal of trees) is not a management action that is acceptable to the community; targeted tree removal may also increase site openness and site attractiveness to little corellas, compounding site problems

- **Habitat modification** to reduce the attractiveness of problem sites and surrounding areas to little corellas, including large-scale habitat planning (e.g. including parks, street trees and paddock wind breaks) to:
    - Increase the **density of trees** (little corellas prefer narrow corridors of trees, which provide vantage points for safety)
    - Increase **understory planting** (e.g. shrubs and groundcovers; little corellas prefer trees without understorey as open habitats provide vantage points for safety)
    - Decrease **irrigated lawn areas** (e.g. some areas of irrigated lawn can be replaced with native plantings that are more water efficient, or interspersed with islands of native vegetation while maintaining park amenity)
    - Increase "**nativeness**". This action enhances local biodiversity, increasing *inter-specific competition* (i.e. competition for resources from other birds). Further, some exotic plants provide far greater food resources than equivalent native species would provide (e.g. Aleppo pines compared to sheoaks or hakeas). Therefore, exotic species should be replaced by native species where possible and acceptable (considering community expectations and potential impacts on other species such as black cockatoos)
    - Modification of problem sites must be done in a strategic way (i.e. considering the broader landscape, all management resources and potential partnerships), which is **sensitive to community needs**
- **Proactive management** should consider sites where little corellas are currently problematic as well as sites where little corellas or other bird species may become problematic in the future. In some locations the 'problem site' is quite obviously the central park in a town (usually along a creek). However, in some cases the problem is more dispersed, where little corellas have plentiful food, water and roost resources (e.g. along the Murray River). In these cases the initial focus needs to be in the most affected areas (e.g. where the community feel the 'biggest' problem exists). Additionally, little corellas may continue to increase in distribution across the state. While the actions described here are designed specifically for little corella problem sites, they will also reduce the chance of other urban adapting/exploiting bird species becoming problematic (e.g. noisy minors, sulphur-crested cockatoos, ibis and rainbow lorikeets). A long-term guided approach to **threat abatement**, including proactive management, will minimise future impacts of current and emerging *urban-adapting* and *urban exploiting* species
- **Development of a management planning template**: local governments across South Australia should use a management-planning template, based on these recommendations. The aim of the template is to streamline the development of little corella management plans among local councils, and provide the architecture for amending existing strategies. The template should include the glossary from this document to facilitate consistent terminology. This approach will create state-wide uniformity in the management plans. The template must include a strategic and integrated approach to little corella management, with long-, medium- and short-term actions for each local government area, and identify sites where little corellas are problematic
- **Further research**: our focus has been on little corellas in urban and peri-urban areas, including regional townships. Further research into resource availability for little corellas in regional (ex-urban) areas, and how best to reduce these resources is needed; agricultural food and water resources are of particular interest

Medium-term actions and considerations

Medium-term actions include planning on a 2-9 year timeframe, with actions to be commenced as soon as possible. Medium-term actions should only commence once long-term actions have been planned and set-in-motion. Medium-term actions and considerations include:

- Information sharing and strategic management requires the **establishment of a forum for discussion among groups** and individuals involved in the management of little corellas around South Australia, particularly among local government areas, and with community and state government input. We recommend:
    - Annual community meetings in areas with problem sites
    - Annual meetings of staff involved in the management of little corellas and related community education (from local and state government, and NRM Boards). While this report is focussed on little corellas, we recognise that other, similar issues exist around the state, and therefore recommend the meeting be an **Abundant Bird Species Forum**, to encourage collaboration and the sharing of knowledge in relation to the management of, and education about, abundant bird species in South Australia. These forums should include training in the use of ***Mental Modeler*** for running little corella management scenarios for management and educational purposes
    - A review of progress every six years, including data collection from the wider community, local government, state government and NRM Boards. The reviews of progress should repeat a social survey, community workshops, and field surveys as conducted during the ***Little Corellas*** project in order to measure change in social and environmental factors. A literature review should also be conducted to incorporate any related new research findings into management and to update ongoing education initiatives. These reviews should be planned and managed in collaboration with any long-term research (described above)
- Increasing **information and education** to increase public knowledge and tolerance of little corellas, as well as **acceptance of management actions**. Public expectations need to be realistic and based on an understanding of social and environmental factors, as well as management practices. Education should include:
    - **Consistent terminology** (see glossary in his document)
    - **The relationship between the habitat we create and the species it attracts** (i.e. little corellas and other problematic bird species are not in themselves problematic; these species are utilising resources that we provide for them including open habitat, food and water resources)
    - **The complexities and costs associated with the management of little corellas**. The 'Mental Modeler' models created for this project are available online and useful in explaining these issues
- Creation of ***sacrificial sites*** as a refuge for little corellas. Land managers and relevant stakeholders should plan, identify and survey potential sacrificial areas and consult widely with those who may be impacted at these sites. If a suitable sacrificial site is available, short-term 'disruption' actions should be orchestrated to promote little corella movement to the sacrificial site. Further details about sacrificial sites are available within this document (here)

Short-term actions and considerations

Short-term actions include planning on an annual timeframe, with actions to be commenced as required. Short-term actions should only commence once long- and medium-term actions have been planned and set-in-motion. Short-term actions and considerations include:

- **Disruption of little corellas at problem sites**. It is important to note that disruption is best done when little corellas have somewhere else to go (e.g. a sacrificial area) and in conjunction with long-term plans to reduce the attractiveness of the problem site (so that little corellas are less likely to return and **habitual behaviours are affected**). While disruption can be immediately effective (i.e. the birds fly away), without the medium- and long-term strategies described above, the effectiveness of disruption will likely be short-lived (birds will return unless they have somewhere better to go, a sacrificial site)
- Disruptive activities can include:
    - **Spotlighting** (hand-held or automatic)
    - **Noise generation** (hand-held or automatic, including clapping, starter-pistols, guns, gas guns)
    - **Lasers** (hand-held)
    - **Lethal deterrents** (shooting to deter flocks)
- Some disruptive activities may be unacceptable to the local community (e.g. lethal actions in built-up areas and noise generation in residential areas). However, activities may be accepted with engagement and education so that the community understand how the actions fit in with the overall strategy. For example, the acceptance of lethal deterrents may be increased where lethal deterrents are used to increase the effectiveness of non-lethal measures, where the strategic approach is understood by the community, and where lethal deterrents are clearly differentiated from lethal controls see our section about communication barriers, discussed as part of the Community Workshop outcomes)
- Many managers around the state have extensive experience and have had some success at moving little corellas away from problem sites – out of towns and into sacrificial sites (e.g. in The Flinders Ranges Council area). These operators can provide expert knowledge and advice to other managers (i.e. through an Abundant Bird Species Forum), promoting communication and information sharing among groups

Responsibility for management actions

A broad level of collaboration and engagement is required to manage little corellas in South Australia. Local government manages most of the sites where little corellas are problematic. With our proposed **focus away from controlling birds** and on to **landscape management**, it is reasonable that local government will continue to make an important contribution to the management of little corellas. However, we recommend increased support for local government. Increased support is already evident through the collaboration of state government, the LGA, universities, and local communities on the ***Little Corellas*** project. State government is also taking responsibility for the development of a state-wide management strategy. Further opportunities exist to collaborate with NRM Boards and other organisations like Birds SA, Conservation Volunteers, Greening Australia, Landcare Australia,

Trees for Life, local plant nurseries, community groups and individuals, agricultural and grain groups. These groups and individuals can assist with community development, revegetation activities and giving advice. It is important to ensure that all groups and individuals are working collaboratively towards the common goals outlined in the local government management plans (described above). See Table 1 below for the types of relevant activities that each group does.

Actions recommended above should be supported as follows:

- Natural Resources Management Boards (NRM Boards) should support local councils to plan and implement landscape management, collaborating with other affected landholders (e.g. schools and private landholders)
- Local councils and NRM Boards should facilitate annual community meetings
- LGA and DEWNR should facilitate annual meetings of local and state government staff
- Funding for long-term research should be sought through traditional research grants with leverage funding provided by state government, the LGA and NRM Boards
- Reviews of progress should be conducted by state government, the LGA and NRM Boards
- Whole-of-council approach: in addition to collaborating with other councils and agencies (e.g. NRM, schools) and individuals to manage little corellas, councils should spread the burden of management within their agencies. Pest animal managers should work closely with parks and maintenance staff, environmental and natural resource managers, arborists, town planners and others to develop cohesive plans for problem sites and areas
- DEWNR should provide policy and scientific/environmental management advice to guide available actions to reduce impacts of little corellas at problem sites
- Local community groups and individuals can provide volunteer hands-on assistance with revegetation activities, and identifying water, food and roost resources, in and around urban areas

***Table 1** Relevant organisations and groups for potential collaborations, and their activities*

ORGANISATION/GROUPS	SUPPORTED ACTIVITIES
Bird groups: Birds SA, Birdlife Australia (including Birdlife Kangaroo Island and Birdlife South East SA)	Promotes local interest and awareness of birds; conducts bird conservation work; provides a source of scientific expertise and speciality knowledge of birds and bird ecology; manages bird resources
Conservation Volunteers	Works in partnership with government (all levels) and communities on environmental projects; mobilises and coordinates volunteers for land restoration, revegetation and weed control activities
Greening Australia	Works on landscape-scale projects, including WildEyre in South Australia; focuses on environmental projects that encourage involvement (and engagement) of local communities
Landcare Australia	A community owned and driven initiative, works on integrating management of environmental resources and farmland (e.g. weed control), and promotes sustainable management of private land. Also manages resources for local groups and activities
Trees for Life	A community-based organisation that works on land restoration, revegetation and conservation projects (including establishing biodiverse plantings on private land, and regenerating bushland)
Local plant nurseries	Can grow locally native plant species for sale and provide information around their use and importance, may decease availability or discourage the purchase of declared weeds
Community groups and individuals	Can be engaged and mobilised to promote biodiverse landscapes at schools and private gardens, for example
Agricultural and grain handling groups	Large grain storage and handling groups, such as Viterra, conduct little corella control activities at some sites; pest managers there may be able to share information and collaborate with councils to enhance the effectiveness of control activities more broadly

Glossary of Terms (relative to little corellas)

Call birds	Or early birds; small numbers of birds that arrive in an area before the main flock. See also “Scout birds”
Citizen Science	A scientific endeavour generating new knowledge or understanding that actively involves citizens; the citizens collaborate with scientists and have meaningful roles in projects
Controls	Management activities that include lethal and non-lethal actions that aim to deter or remove birds (or reduce their numbers) in an area in order to reduce their impacts. See page 30
Carrying capacity	The greatest number of little corellas that an area can support, given the available resources
Cull	To destroy (kill) birds, usually in large numbers, to reduce the overall population size. See also “Lethal population control”
Dietary breadth	A measure of diet variety; highly specialised species have a narrow dietary breadth (specialising on a single food source perhaps), whereas generalist species have great dietary breadth and would feed on many different types of food
Exotic plants	Non-native plant species, also called weeds, introduced plants; can include Australian native plants that are not indigenous (i.e. from other places in Australia)
Exterminate	To destroy (kill) every individual bird and remove the species entirely and permanently from all areas (synonymous with extinction); see also “Cull”; “Lethal Population Control”
Flock	A large number of birds congregating together in a single area; a few birds does not constitute a flock. See also “Flocking behaviour”
Flocking behaviour	A common and natural behaviour in many bird species; cockatoos are highly social and vocal birds, and flocking allows social bonds to develop and provides some safety against predators
Habitat	The environment in which an organism exists and derives its needs; little corella habitat includes roosting and nesting, watering and feeding areas
Habitat modification	Modifying habitat in some way, such as planting reeds along water banks or increasing shrub cover; as a management strategy, habitat modification may be used to attract or deter particular wildlife from target areas
Human-wildlife conflict	Experience of negative interactions with wildlife; causes of this conflict can be varied, from real or perceived danger (i.e. dangerous animals), to economic losses (e.g. crop losses), to a reduction in amenity (e.g. damaging trees or fouling of water)

Inter-specific competition	The competition for resources among species, including from other birds
"Landscape of fear"	An ecological term that describes the level of fear of predators felt by a prey species in its environment; creating a "landscape of fear" involves increasing perceived risk
Lethal deterrent	Lethal destruction of a small number of birds in order to deter a large flock of birds from the area, typically used in conjunction with non-lethal measures
Lethal population control	Lethal destruction of a large number of birds in order to reduce overall population size. See also "Cull"
Loafing behaviour	Loafing areas are where little corellas digest food, preen, play and rest (different to feeding or watering behaviour, for example)
Local enhancement	When the presence (calls and activities) of a few little corellas attracts more little corellas to that area
Mind map	Information organised in a diagram, which shows relationships between different factors associated with a central idea
Mental Models	The output from community workshops using the Mental Modeler software (developed by S. Gray). The models capture experiences and knowledge about little corellas, and can illustrate the outcomes of different management scenarios
Nesting habitat	Hollows in large trees and cliffs comprise nesting habitat for little corellas. Nesting behaviour (forming pair bonds and rearing young) is different to roosting behaviour. Compare "Roosting"
Non-lethal deterrent	Non-lethal actions that deter birds from an area; making noise and flashing lights are typical non-lethal measures
Population reduction	To destroy large numbers of birds to reduce the overall population size. See also "Lethal population control" and "Cull"
Positive reinforcement	Positive reinforcement involves the use of an additional measure (e.g. a lethal deterrent) to reinforce non-lethal activities, with the aim of increasing the effectiveness of the non-lethal activities
Problem site	The ***Little Corellas*** project focused on sites identified by participants, where the presence of little corellas is of concern to them, and where management action is wanted. Problem sites may include those with large numbers of birds creating mess and noise or other factors, such as dispute about management at that site
Resident flocks	Traditionally, little corellas form large flocks during warm months in the southern areas and form pair-bonds and disperse north during winter to breed; however, some southern areas are now experiencing small resident flocks of little corellas that persist year-round
Roosting	Birds sleep at their roosts, typically little corellas settle at night in large roost trees. Compare "Nesting"

Sacrificial sites or areas	Identified, suitable areas deliberately set aside for little corella habitat as part of integrated management activities; little corellas are not be moved on from these sites. Where possible, management plans should identify sacrificial areas and strategies to encourage birds to these areas and away from problem areas. The term “sacrificial” in this context does not imply that the site is of no value, but that the area is set aside for this purpose
Scout bird	Or early bird (see also “Call bird”); small numbers of birds that arrive in an area ahead of a main flock. Scout bird is an imprecise term implying that birds report back to other birds in an organised and strategic way about their planned movements, which they don't. Early bird or call bird are preferred terms. See also “Local enhancement”
Trap and gas/euthanize	A method of “Lethal population control”, where birds are captured and then destroyed by carbon dioxide narcosis
Urban adapters	Species that live in natural and modified areas, e.g. little corellas. Compare “Urban avoiders”, “Urban exploiters”
Urban avoiders	Sensitive species that disappear or decline with urban development, e.g. wrens. Compare “Urban adapters”, “Urban exploiters”
Urban exploiters	Species that thrive in modified areas and even depend on urban resources; e.g. rock dove, house mouse and red-backed spiders. Compare “Urban adapters”, “Urban avoiders”
Vocalications	Sounds made by birds that include calls and screeches, which are important for bird communication, e.g. alarm calls, social calls
Wildlife acceptance capacity	A measure of human tolerance of a wildlife species or of a situation involving wildlife (e.g. little corella acceptance capacity), assessed locally or for the general public depending on the situation. Tolerance varies with attitudes, values, background and experiences or understanding of the problem. Varying levels of wildlife acceptance help explain contention surrounding the management of little corellas in some areas. For example, some people enjoy seeing large flocks of little corellas and oppose any control activities whereas other people may have bad experiences with them, do not enjoy seeing them, and want them controlled

Acronyms

DEWNR	Department of Environment, Water and Natural Resources
NRM	Natural Resources Management
NSW DPI	New South Wales Department of Primary Industry
LGA	Local Government Association of South Australia
NPW Act	*National Parks and Wildlife Act 1972*
UniSA	University of South Australia

Introduction

Scope and purpose of the report

The purpose of this report is to:

- Inform a new **Little Corella Management Plan for South Australia** being developed by the Department of Environment, Water and Natural Resources (DEWNR) in collaboration with the Local Government Association (LGA) of South Australia and other interested parties
- Provide a **relevant and useful resource** that reflects community attitudes towards and experiences with little corellas in South Australia, which is supported by detailed data collection and analysis
- Report back to **community and stakeholder groups** on the findings of the ***Little Corellas*** project
- Help all stakeholders make **informed decisions** about little corellas
- Develop recommendations to **facilitate communication** among and within agencies working on little corella management in South Australia
- Provide recommendations and tools for **strategic and coordinated state-wide approach** to the management of little corellas
- Develop practical and effective recommendations for **landscape-level and site-specific** management of little corellas in South Australia (long-, medium- and short-term actions)

No "silver-bullet" or "solution" to management issues associated with little corellas or other wildlife exists. Rather we aim to identify steps, based on extensive research and consultation, to reduce issues with little corellas. These steps include long-, medium- and short-term actions to alleviate problems at targeted sites. The numbers of little corellas and site problems will continue to increase without long-term coordinated management strategies, and short-term actions are also needed. We focus here on "problem sites" in urban and peri-urban areas, including townships, across South Australia.

Legislation, Permits and codes

Most **native species in South Australia are protected** under the *National Parks and Wildlife Act 1972* (NPW Act), although specific levels of protection may vary among species. **Two corella species** occur in South Australia, and they have two different levels of protection afforded under the NPW Act:

Little corellas (*Cacatua sanguinea*)

- Listed as an "unprotected" species under Schedule 10 of the NPW Act because they are abundant and can be destructive
- Landowners and shooters acting for landowners **do not** require a *Permit to Destroy Wildlife*, they can shoot an unlimited number of little corellas on their land
- Shooters must comply with the *Code of Practice for the humane destruction of birds by shooting in South Australia* and with **all provisions** of the *Firearms Act 2015*; including those relevant to the storage, transportation and use of firearms and ammunitions
- Lethal trapping and gassing of little corellas requires a permit

Long-billed corellas (*Cacatua tenuirostris*)

- Long-billed corellas are sometimes mistakenly identified as little corellas
- Listed as "protected" species under the NPW Act, they are not considered to be abundant
- Long-billed corellas were highly threatened and in decline until the 1970s when they started exploiting new cropping resources, their numbers and range have now recovered and even expanded into some areas
- Their natural range includes the south east of South Australia, and a *Permit to Destroy Wildlife* **is required** to destroy them

Department of Environment, Water and Natural Resources (DEWNR) has developed Codes of Practice for the destruction of birds in South Australia and provides training and accreditation to ensure that managers have sufficient knowledge of bird behaviour, know how to use the traps effectively and give due consideration to the welfare of the animals being caught. DEWNR has also developed a series of guidelines and action plans, undertaken ecological research, convened expert reference groups and committees to help define the problems, develop management plans, implement plans and evaluate results. DEWNR provides scientific and technical advice to local councils regarding the various control methods available to minimise impacts of little corellas on communities and individuals.

Background to little corella problem sites in South Australia

Worldwide, there are hundreds of different species of parrots. They are intelligent birds, often brightly coloured, with curved bills, an upright stance and distinctive feet (two toes forwards and two toes backwards). Cockatoos are a family of parrots found in Australasia, from southern Australia to as far north as the Philippines. Cockatoos nest in tree hollows and are monogamous (they form long-lasting pair-bonds for breeding). Common Australian cockatoos are galahs, sulphur-crested cockatoos, cockatiels, long-billed corellas and little corellas.

While many people enjoy seeing these native birds, large flocks of cockatoos in urban and rural areas can cause considerable problems in the warmer months. The most common problems are damage to trees (defoliation), taking grain and disturbing residents with loud vocalisations. Little corellas can also damage buildings, particularly when they chew flashing or wiring, and to tarpaulins, wooden structures, cars and a variety of crops (Photo panel 1).

Significant public contention exists regarding the management of little corellas in South Australia.

Photo panel 1 *Little corellas can cause damage to infrastructure by chewing wiring and flashing (A, B); they can also cause serious defoliation of trees (C)*

A mixed-methods approach to investigate a contentious environmental issue

This research project focused on sites, identified by participants, where little corellas are causing significant problems and where management actions may be required. Problem sites were defined as those areas where large numbers of birds were impacting on site amenity and areas where management actions were locally disputed. Sites were considered problematic if some members of the local community declared them as such (agreement was not required among all members of the community as a site can be a problem for some, but not for others). We aimed to collect existing knowledge and ideas from local communities to explore what made those particular sites problematic. We also aimed to understand the intrinsic factors leading to particular sites being popular with flocks of little corellas and what were the problems faced by the local community.

- This project report **makes practical recommendations** designed to directly influence decision makers and stakeholders so that they can make informed little corella management plans to help reduce the occurrence of problem sites
- The research project involved the local community as much as possible – a "citizen science" approach. The benefit of this approach was that it ensured that all stakeholders had the best-possible understanding of the complex ecological and social dynamics that determine sites where little corellas are reported as problematic. The participatory approach and sharing of knowledge generation maximised learning, **built community resilience and increased ownership of the outcomes of the project** for the people involved.

Human-wildlife conflict

Human-wildlife conflict **is not unusual**; it is formed by negative experiences with wildlife, and is largely a result of human activities and our **modification of the landscape**. Globally, causes of human-wildlife conflict include:

- **Agricultural areas** expanding into the habitats of animals that can damage or consume crops, livestock and infrastructure. For example, in Africa, elephants eat and trample crops and damage farm infrastructure. Elephants are sometimes shot or poisoned in retaliation. Thus, the human-elephant conflict has poor outcomes for both people and elephants.
- **Residential areas** expanding into the habitats of animals that are (or are perceived to be) dangerous or annoying to people (e.g. wolves, bears, and birds that swoop or are noisy). It should be noted that residential development often displaces wildlife by removing resources such as foraging grounds, roosting trees or shelter. Conversely, residential areas can also attract wildlife by providing these same resources, albeit in a different context. Both displacement and attraction of wildlife can generate human-wildlife conflict.

Two South Australian examples of human-wildlife conflict are:

1 ***Common brushtail possums*** were once common and widely distributed across South Australia, but changes to the landscape, including the removal of trees for agriculture, has led to largescale declines and the species is now listed as rare under the *National Parks and Wildlife Act 1972*. In contrast, in highly urban landscapes changes have benefited brushtail possums and their abundance in these areas is relatively high. Urban brushtails can generate conflict when

they inhabit and cause damage inside residential roof spaces (a substitute for a tree-hollow), damage ornamental gardens and make excessive noise at night.

2 ***Grey-headed flying foxes*** are listed nationally as vulnerable and rare in South Australia. However, in several large urban centres including Cairns, Brisbane, Sydney, Melbourne, Geelong and Adelaide, flying foxes roost in large numbers forming "camps". Urban areas provide year-round food and water supplies, including from native and non-native urban tree plantings. Human-wildlife conflict can occur when people get upset about the flying foxes damaging trees, producing excessive noise and droppings in urban areas.

Although wildlife are directly involved in human-wildlife conflict, they are not always the crux of the conflict. Human-wildlife conflict may sometimes be more accurately described as **human-human conflict over wildlife** according to Charles and Linklater (2013). Wildlife managers have to grapple with practical problems associated with urban wildlife, as well as public expectations, which may be divergent. For example, in both of the South Australian examples above, there are people who support attracting these species into urban areas and people who support discouraging the species from urban areas.

While humans may respond in different ways to wildlife, wildlife also responds in different ways to humans. Some species of wildlife do not persist in urban areas. These species may not be able to find enough suitable food or shelter, or they may be susceptible to predation in an urban environment. They are termed "**urban avoiders**" and examples include small woodland birds, like wrens and thornbills. In contrast, some species persist in urban areas, as well as persisting in their natural habitats. These species find the resources they need amongst the urban matrix of buildings, streets and parks. They are termed "**urban adaptors**" and both and brushtail possums and grey-headed flying foxes fit in this category, as do little corellas. One further category of wildlife response to urbanisation exists, the "**urban exploiters**". These species exist in urban areas, but are not typically found in natural habitats. Urban exploiters include house mice and red-back spiders.

The range of foods that an animal will consume is known as the dietary breadth of the species. While some species will consume only a limited range of foods, others will consume a varied diet. In urban areas, an ability to exploit a variety of foods enables ready access to abundant urban foods. Abundant food can enable population growth and **increased densities,** which test human tolerance levels and **amplify conflict** experiences. For little corellas, the abundance and permanency of urban and peri-urban food resources may also **reduce the need for seasonal movements** and increase the permanency of flocks (i.e. increases in "resident flocks", see Glossary).

Human-bird conflict

Typically[a], negative experiences with birds leading to conflict in urban areas relates to one or more of these actions:

1. Nesting or roosting behaviours and locations
2. Aggressive behaviours, including attacking humans
3. Fouling of non-roost sites
4. Damaging infrastructure

[a] See Charles and Linklater (2013)

Feral pigeons or rock doves are non-native birds found in large numbers in many Australian towns and cities. Their **great dietary breadth** (including scavenging for food scraps) and **flexible roosting** requirements (including a variety of urban structures) enables them to exploit urban areas successfully. SA Health identify the transmission of disease, odour and noise issues and damage to infrastructure as health risks associated with feral pigeons and the Australian Transport Safety Bureau consider rock doves to be "a serious risk to aircraft as they take off". Many local councils in South Australia have control programs for feral pigeons within their Animal Management Plans (e.g. Town of Gawler).

Native Australian crows and ravens occur in diverse habitats and some are very common in cities and suburbs of southern Australia. As scavengers and predators, their broad omnivorous diet includes meat, insects, fruit, vegetables, bread, crop seeds, eggs, nectar and foliage (see NSW Department of Primary Industry's, DPI, Crows and ravens Fact Sheet). Australian ravens can create disease risk, mess and excessive noise, they attack other birds, and damage infrastructure. Crows and ravens also damage agricultural and backyard crops of fruits, grains and nuts (e.g. grapes, cherries, olives, plums, berries, pineapples, passionfruit, potatoes, almonds, peanuts).

It is important to recognise that both introduced and native Australian species can generate human-bird conflict in urban areas. Research in many towns and cities around the world has demonstrated some similarities in the way bird species respond to urbanisation. Typically, as urbanisation increases, the number of bird species decreases. Highly urban areas provide resources for only a small number of species, including the introduced species of urban exploiters, like blackbirds and starlings. Urban areas also tend to have quite similar groups of birds present, regardless of where they are in the world, including mostly larger omnivorous and granivorous birds[b], like little corellas.

While both introduced and native species can generate human-wildlife conflict, there should be a preference for supporting a range of **native species** in cities. Supporting native biodiversity can be beneficial for both birds and humans. Urban areas can support a range of bird species, rather than being dominated by the urban exploiters. Indeed, well planned residential areas can attract and support a diversity of bird species, including species that typically avoid urban areas, like small woodland birds. Supporting small woodland birds is important as many of these species are in decline.

Urban areas with a **diversity of plants and birds are beneficial to people**. Australians certainly appreciate the natural environment in and around Australian cities, demonstrated in a 2014 Property Council report[c] where residents scored various attributes of the cities they lived in. The two most highly-ranked attributes were the range of recreational outdoor environments and the attractiveness of the natural environment. While we may intuitively like to live in attractive natural environment with recreational opportunities, research also shows that living and working in more natural environments improves health and productivity, and may increase house prices[d].

[b] Chance and Walsh (2006) Urban effects on native avifauna: a review. *Landscape and Urban Planning* 74(1): 46-69

[c] Property Council of Australia (2014) My City Report

[d] See Roetman and Daniels (2008)

Biology and ecology of little corellas[e]

Description

Little corellas are a small white cockatoo with body length 35-40 cm and body mass 430-580 g. They have a short upright crest, bare blue-grey skin around the eye and salmon-pink lores (the area between the eyes and nostrils). The underwing and undertail feathers are pale yellow. Little corellas are not sexually dimorphic, i.e. male and female birds are indistinguishable with external examination. Little corellas do look similar to long-billed corellas, but unlike long-billed corellas, little corellas have no red breast feathers and they have a relatively short bill; see photo 1.

Little corellas naturally form large, noisy flocks during warm months; their vocalisations include guttural sounds and high-pitch screeches.

Photo 1 *Little corella (above and below right) and long-billed corella (below left)*

Distribution

Pre-European distribution is poorly understood, and is inferred from records of early pastoralists, explorers and naturalists. Until the 1920s little corellas appear to have been largely restricted to the far north east of South Australia. Since then **little corellas have extended their range slowly southwards**; from the 1960s onwards little corellas were recorded continuously and increasingly in the Flinders Ranges, Mount Lofty Ranges and surrounding areas. This movement was probably facilitated by native vegetation clearance as well as the provisions of new permanent water sources (e.g. stock troughs, dams), food from grain crops, and other factors such as drought. In addition to their range expansion, little corellas appear to have increased in abundance (DEH, 2007).

Little corellas are now widespread throughout inland, western and northern Australia. In South Australia little corellas are common in the eastern parts of the state, including: the Mid North, North East, Flinders Ranges, Riverland, Adelaide Plains, Fleurieu Peninsula, Kangaroo Island and in the South East. Little corellas often congregate along tree-lined watercourses from adjacent plains. They have been observed in a wide variety of other habitats including savannah woodland, mallee, mulga, rangelands, spinifex sandhills, gibber, saltbush, native cypress, crops, stubble, mangroves, offshore islands, dams, tanks and cliffs. Increasingly, little corellas occur in urban areas (i.e. “Urban adaptors”).

Reproduction

Between May and September little corellas spread out across a vast landscape in their breeding pairs or small family groups. Breeding usually occurs from August to October; typical nesting sites are tree hollows lined with decayed woody fragments, however little corellas will also excavate cavities in cliffs and in termite mounds to nest in. Two to four white oval eggs are laid per clutch; the incubation period is 24-26 days, and parents share incubation duties and caring for the young. After seven weeks the fledglings and parents join a large nomadic foraging flock, which increases their individual safety. In contrast to the large raucous summer flocks of little corellas, breeding birds are quiet and somewhat inconspicuous. The species is long-lived with captive individuals reaching in excess of 50 years of age, although wild animals are unlikely to reach this age.

[e] Modified from DEH (2007) and references therein, and from Simpson and Day (2004), St John (1994), and Rowley (1997) in DEH 2007

Food, water and roosting resources

Little corellas are strong fliers that can travel great distances in search of food, water, roosting and nesting resources, or the safety of a larger flock. The species has habitual roosting sites that flocks return to in successive years (DEH, 2007). However, flock composition is not fixed and individual birds may move among different flocks and roosts each year (DEH, 2007).

At their roosts little corellas preen and socialise. They use loud vocalisations to communicate regularly with the other members of the flock. They also defoliate their roost trees to **create a clear view, increasing visibility of the site and their perceptions of safety from potential predators (e.g. raptors)**.

Roost sites tend to be established near accessible fresh water and food resources. Little corellas are opportunistic foragers of food. For example, in spring they will feed on grass seeds and bulbs, in summer they may congregate in large numbers to feed on stubble remains in paddocks after harvest, and in late summer-autumn they might exploit grain around stock feed troughs. In the southern Flinders Ranges they feed almost exclusively on fallen grain in stubble paddocks. They also exploit artificial water sources (e.g. stock troughs, dams and lakes).

History of little corella problems

Many local council areas have a history of problems with little corellas, and they have invested **significant resources into developing strategies** for their management (see Figure 1). Extensive experience and knowledge of little corellas exists within these individual agencies and communities, but little information sharing or coordination of activities occurs among councils, and the efforts of **some councils maybe frustrated by the inaction** (or uncoordinated actions) of others. A state-wide strategy that umbrellas local plans is needed; **streamlining access to management resources for local actions should improve uptake and coordination of management activities across the state.**

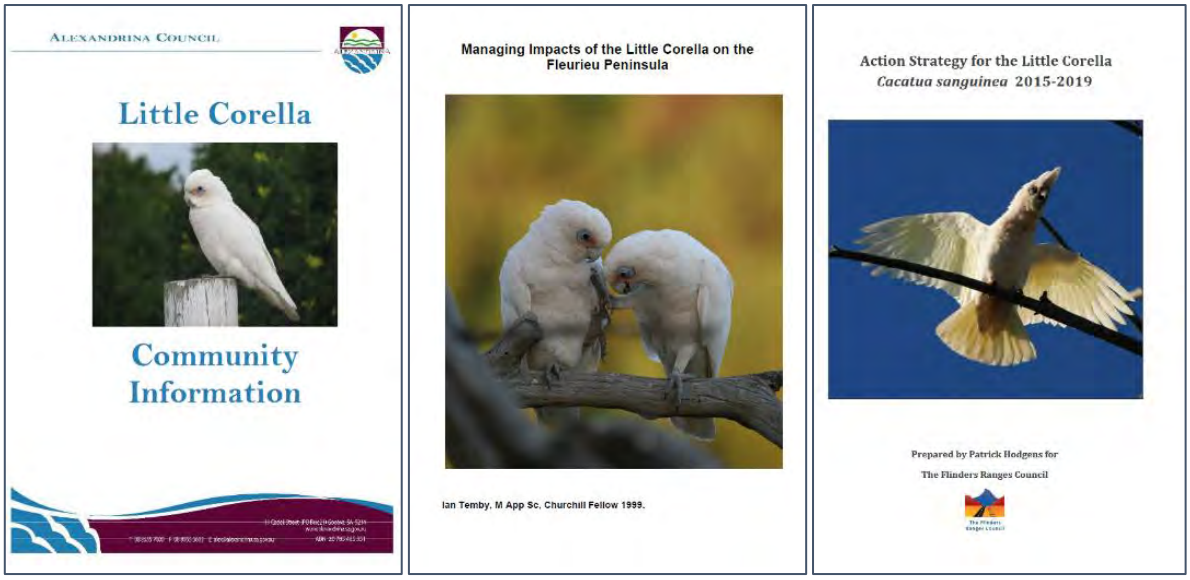


Figure 1 *Many local councils have invested significant resources into developing materials for the community and management strategies for little corellas*

Our mixed-methods approach

The ***Little Corellas*** project was conducted during 2015 and 2016. The project had a number of distinct phases using a variety of methods to help us understand community experiences of little corellas, how little corellas are managed, and to develop recommendations for future management.

Phase 1: Online survey

We developed a short online survey to collect information about people's opinions of and experiences with little corellas. The survey was designed to identify people and places to involve in subsequent phases of the project. The survey was open from November 2015 to March 2016 (5 months), with traditional and social media used to encourage community participation. The survey was also promoted by project collaborators, and paper copies of the survey were available.

Phase 2: Community workshops – creating interactive "Mental Models"

We hosted nine community workshops across the state with people affected by, or concerned about, little corellas. At the workshops we explored causes of problem locations using purpose-built software called ***Mental Modeler***, which was developed by project collaborator Dr Steven Gray of Michigan State University. The software enabled participants to share their ideas and concerns about little corellas. In each workshop we created interactive maps of this complex problem, which included defining relationships between components and creating scenarios for different management regimes. Workshops were held during December 2015 and January 2016 in Hawker, Milang, Onkaparinga, Quorn and Strathalbyn, and two workshops each were held in of Gawler and Mount Barker. The community models were made available to view and download, along with instructions on how to edit and run the models (http://www.discoverycircle.org.au/projects/little-corellas/community-models/).

Phase 3: Field data collection at little corella sites

We visited over 150 sites **identified by survey participants** as locations where little corellas are causing problems for local people, and we surveyed 144 of these sites across South Australia (see Figure 2). Survey areas included: metropolitan Adelaide, Aldinga, Birdwood, Clayton Bay, Cockatoo Valley, Crystal Brook, Gawler, Goolwa, Hawker, Hewett, Mannum, Melrose, Milang, Mount Barker, Murray Bridge, Nuriootpa, Old Noarlunga, Palmer, Port Augusta, Port Elliot, Quorn, Roseworthy, Sandy Creek, Snowtown, Strathalbyn, Tailem Bend, Tanunda, Two Wells, Victor Harbor, Virginia, Williamstown and Wilmington. At each site we assessed and recorded the habitat type, and estimated the nativeness and cover of ground layer, shrub and tree vegetation (see details in Table 2).

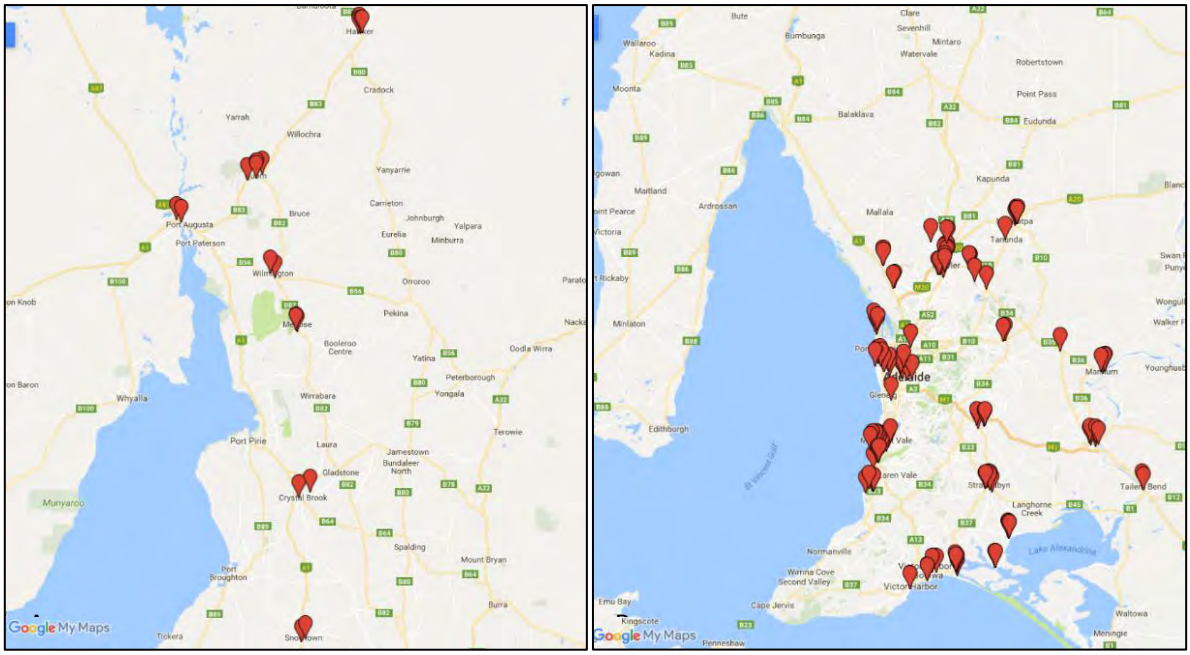


Figure 2 *Maps of sites surveyed during the **Little Corellas** project; sites were identified from a community survey*

A) Sites ranging from Hawker to Snowtown; B) Nuriootpa to Victor Harbor

Table 2 *Scoring system for estimating nativeness and cover of ground, shrub and tree vegetation at little corella sites*

NATIVENESS (0-5)	COVER (0-6)
0. Zero, or nearly zero species	**0.** Zero cover, or almost zero cover
1. Exclusively, almost exclusively exotic species	**1.** Sparse cover, < 5%
2. Mostly exotic species	**2.** Plentiful, but little cover < 5%
3. Mixed native and exotic species	**3.** Cover of 5 to 25%
4. Mostly native species	**4.** Cover of 26 to 50%
5. Exclusively, almost exclusively native species	**5.** Cover of 51 to 75%
	6. Cover of >76%

We also noted the presence, abundance and height of tree species of interest at each site. Species of interest were determined from the literature and from survey responses, they were: Aleppo pines, Norfolk Island pines, Monterey pines, native pines, other conifers, sheoaks, river red gums, other gums and native trees, fruit trees and ornamental trees. The overall cover for all trees was recorded, and we recorded whether any visible tree damage or perceived damage/reduced amenity by little corellas (including defoliation, tree pruning and mess from pruning) was present at the site.

In terms of water resources, we recorded whether the site had: 1) irrigated areas, 2) a water resource, 3) whether any water resource was permanent or ephemeral, 4) the accessibility of water to little corellas (e.g. vegetation barriers or other barriers) and 5) any other point of interest.

Phase 4: Little corella habitat suitability models

In order to create little corella habitat models for South Australia we asked: *What landscape features favour little corellas in South Australia?* The purpose of the habitat modelling was to:

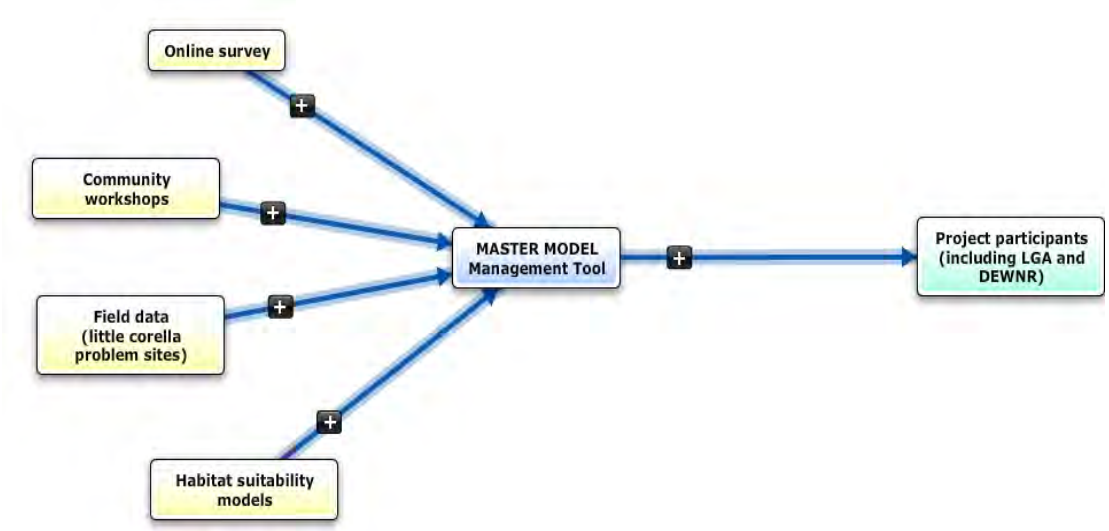
- Understand **little corella distribution across South Australia** (including potential future movements)
- Determine **habitat variables** associated with little corella presence
- Identify **land uses** associated with little corella presence
- Identify potential **habitat management tools** for little corellas

Modelling specifications were:

- Presence-only modelling using community (***Little Corellas*** project) survey data; BirdLife Australia ***BirdAtlas*** data
- Maxent modelling software (version 3.3.3k)
- Habitat variables were identified from the community survey and workshop data, and from a review of the existing literature, they included distance (m) to nearest:
    - Major creek
    - Irrigated green space (i.e. council reserves, golf courses, ovals)
    - Exotic pine
    - Grain storage
    - River red gum

Phase 5: Data synthesis - creating the master model

We synthesised results from the survey and community workshops, as well as from field data collection, habitat modelling and previous research, to **develop a master model for little corella management** using ***Mental Modeler*** software. The master model is available to download and operate from the Discovery Circle, it can also be upgraded and refined as new research or technologies emerge. The model enables users to create different management scenarios for little corellas, and identifies trade-offs and outcomes.



Phase 6: Sharing results

We delivered results from the survey and workshops during the project as they became available. For example, we created a map of little corella sites identified from the survey and posted it on the Discovery's Circle's webpage. The models created during community workshops were also posted there along with an instruction manual for operating the software. Information about the project, getting involved and getting results were posted online (via Facebook, e-mail, Twitter), via postcards and traditional media; see examples in Photo panel 2.

Photo panel 2 *Social (top row) and traditional (bottom row) media was used to promote the project, to increase reach and participation and to update participants on project findings*

Results

The Little Corella Survey

Broad community engagement

- We received a **strong community response** with 1,270 people completing the survey[f]
- In terms of geographic coverage, we recorded **widespread participation** with residents from 60 of 68 (88%) local councils being represented
- **City of Onkaparinga** had the most respondents (16%, or n = 137 respondents), followed by **Alexandrina** Council (9%, n = 76), **Mid Murray** Council (7%, n = 63) and Town of **Gawler** (4%, n = 37). Appendix 1 lists the frequency of respondents per local government area or authority
- Respondents' residential locations were: 51% urban, 30% peri-urban and 19% non-urban

Participant opinions of and experiences with little corellas

- General opinion of little corellas was nominated by participants on a scale from love to hate. We found that **few respondents hated little corellas** outright (4%, n = 53), many more respondents reported to love them (21%, n = 268; see Figure 3). Overall, 60% of respondents reported a positive opinion[g], just 29% reported any negative opinion of little corellas[h]

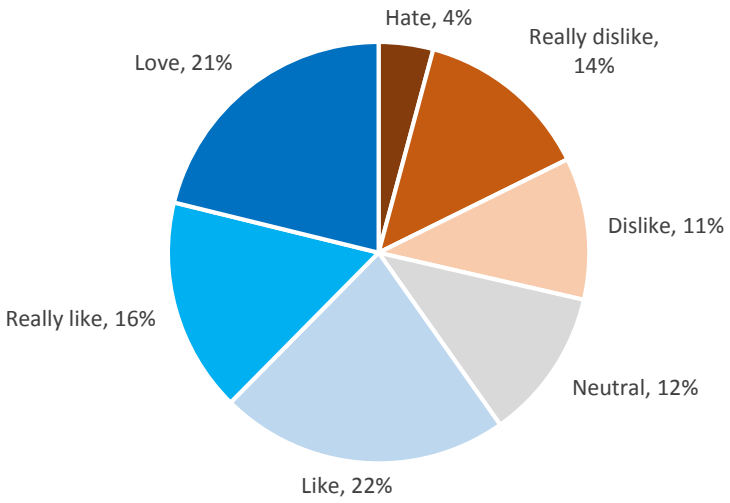


Figure 3 *Survey respondents' general opinion of little corellas*

[f] A total of 1,571 survey responses were received, we removed incomplete surveys (those with only a few questions answered), surveys where participants were unengaged (little or no variation in response, low standard deviation), and repeated surveys

[g] Participants that selected "Love", "Really like", or "Like"

[h] Participants that selected "Hate", "Really dislike", or "Dislike"

- We grouped open-ended responses to the questions: **What do you LIKE about little corellas? What do you NOT like about little corellas?** into the themes that emerged (Tables 3 and4)

Table 3 *Themes in participant responses to the survey question: What do you LIKE about little corellas?*

THEME	COMMENTS
Intrinsic value of native wildlife	Comments about little corellas being native birds, Australian wildlife, biodiversity, part of nature, having a role to play and linked to habitat health
Value to self	Comments about spiritual or sentimental value of little corellas, feeling connected to nature or landscape and loving all creatures
Enjoy seeing them	Comments about enjoying their interactions, behaviours, intelligence, socialising, gregariousness, flocks, calls, or beauty
Other	Miscellaneous comments on infrequent themes
Negative comments	Comments where nothing was liked about little corellas

Table 4 *Themes in participant responses to the survey question: What do you NOT like about little corellas?*

THEME	COMMENTS
Destructive, cause damage	Categorised divided into sub-themes: a. *Destructive, cause damage* – to unspecified objects b. *Damage to infrastructure* – property damage c. *Damage to trees, vegetation* – defoliation, tree deaths d. *Damage to crops, orchards* – damage to crops, seeds, vineyards, fruits, nuts e. *Damage to lawn, grass, greens* – damage to grass
Noise	Comments about excessive noise
Mess, droppings	Comments about large mess, debris
Reduced amenity	Comments about feeling anxious or stressed about little corellas, about their behaviours affecting a lifestyle
Over-abundance	Comments about them being a pest or plague
Disease, health risks	Comments about diseases, mites and rainwater contamination
Reduce biodiversity	Comments about deterring other birds or biodiversity
Community divisions	Comments about other people in the community being upset, feeling upset that people complained about little corellas, creating social divisions and harm and perception and intolerance issues
Other	Miscellaneous comments on infrequent themes
Positive comments	Comments where nothing was disliked about little corellas

What do you LIKE about little corellas?

- Most people **enjoyed seeing little corellas**, they enjoyed their intelligent behaviours, interactions, gregariousness and beauty (48%, n = 519; Photo 2)
- The quotes below demonstrate *Intrinsic value as native wildlife* (Quote 1) and *Value to self* (Quote 2) themes; see Figure 4

Quote 1 "*I enjoy the variety of parrots that come in waves over our property - Galahs followed by little Corellas followed by Sulphur crested and finally Rosellas. The Corellas are part of that cycle and I'm sure have a role to play in the ecosystem*"

Quote 2 "*Corellas are truly Australian. Their call always reminds me of good times camping in the bush as a child. Now that I live in the bush the sight and sound of corellas always makes me smile*"

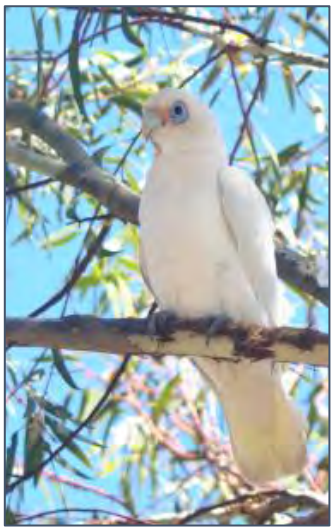


Photo 2 *Many people enjoy seeing little corellas*

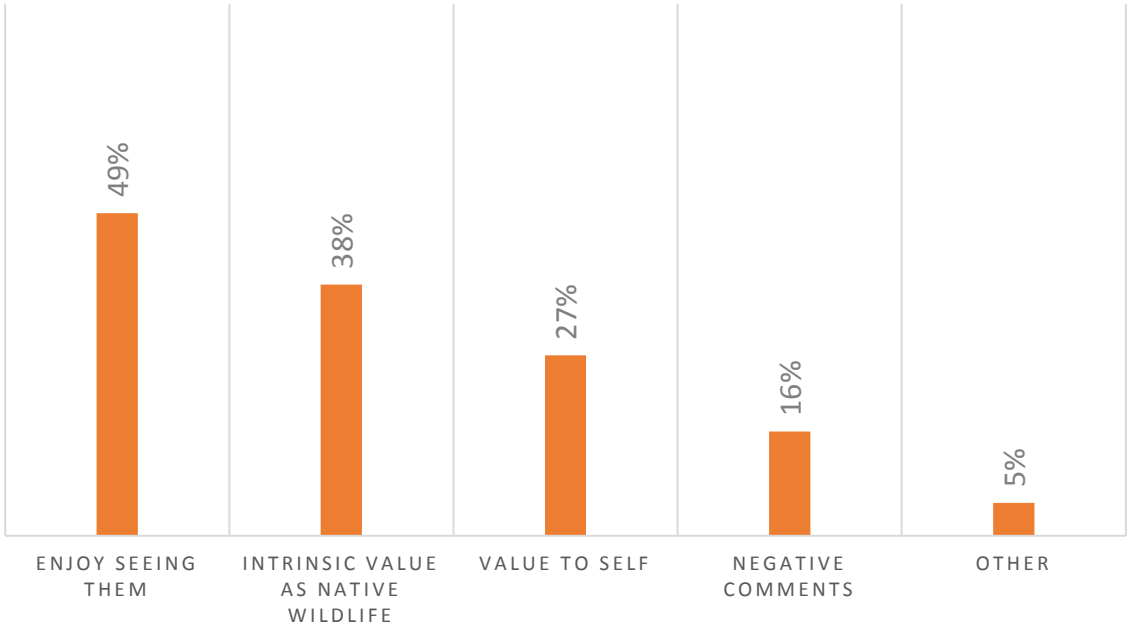


Figure 4 *Participant responses to the question: What do you LIKE about little corellas? Sample size was 1,072 respondents*

What do you NOT like about little corellas?

- Most respondents **disliked the damage caused by little corellas** or their destructive behaviours, highlighted in Figure 5 with red columns (70%, n = 762; Photo 3). Respondents also disliked the **noise** made by little corellas (42%, n = 446); **damage to trees** was most disliked form of damage (28%, n = 301); see Photo panel 3
- Little corellas were perceived to be over-abundant (see Quotes 3 and 4). Some people felt that little corellas were creating community divisions (Quotes 4, 5 and 6); see Figure 5

Quote 3 they are "*noisy, destructive, are in plague proportions and need to be culled*"

Quote 4 "*I don't like their impacts as an over-abundant species. I don't like the way people get passionate about these birds while ignoring their impacts*"

Quote 5 "*They do make a racket. I know they have caused management problems for some towns. A town near us implemented their "de-corella" strategy... and now the corellas have moved onto our town. So now the park is quite noisy and filled with birds*"

Quote 6 "*I don't like people complaining about them*"

Photo 3 *Many people dislike damage to trees by*

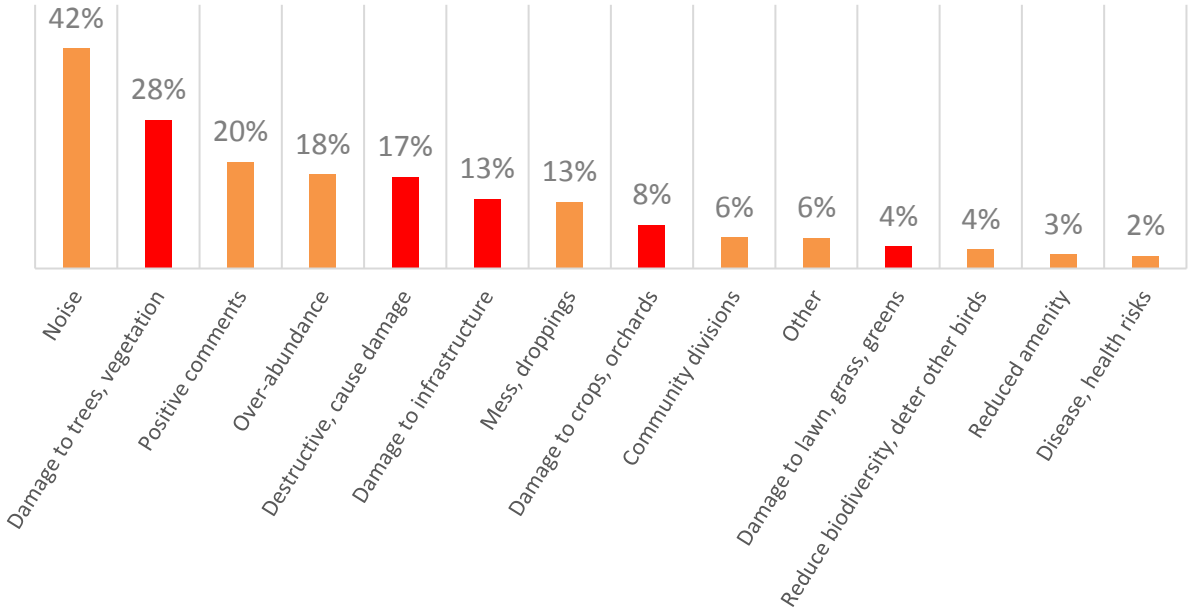


Figure 5 *Participant responses to the question: What do you NOT like about little corellas? Items shaded red all refer to damage caused by little corellas (the cumulative total of these damage-related items is 70%)*

Overall, 1,067 people responded to the question.

Photo panel 3 *Defoliation of trees by little corellas*

A) Norfolk Island pine at Old Noarlunga; B) lemon-scented gum at Lockleys Oval; C) gum tree at Aldinga; D) sugar gums at Palmer; E) Aleppo pine at Old Noarlunga; F) gum tree at Wilmington; G) Norfolk Island pine at Aldinga Hotel; H) gum trees at the Hawker Golf Course

Trends in little corella presence

- Respondents were divided when asked about **how long little corellas had been an issue** in their area. About a third of respondents (33%, n = 367) indicated that little corellas were not a problem. Of the respondents who indicated a problem existed (67%, n = 753), 26% indicated that little corellas had been a problem for 1−5 years, 20% selected 6−10 years, 8% selected 11−15 years and 13% selected 16−20+ years
- About a third of the respondents (34%, n = 395) reported that the little corella population in their area had *stayed the same* in the **last five years**. The same percentage of respondents reported that they would like the population to *stay the same* for the **next five years**
- Almost half (46%, n = 537) the respondents reported that the little corella population had *increased somewhat* or ***increased greatly*** in their area over the last five years. Similarly, 44% (n = 516) of respondents wanted the population to *decrease greatly* or *decrease somewhat* in the next five years. This pattern is repeated, but inversed, when a similar number of respondents that had observed little corellas to decrease in the last five years wanted them to increase in the next five years (see Figure 6)

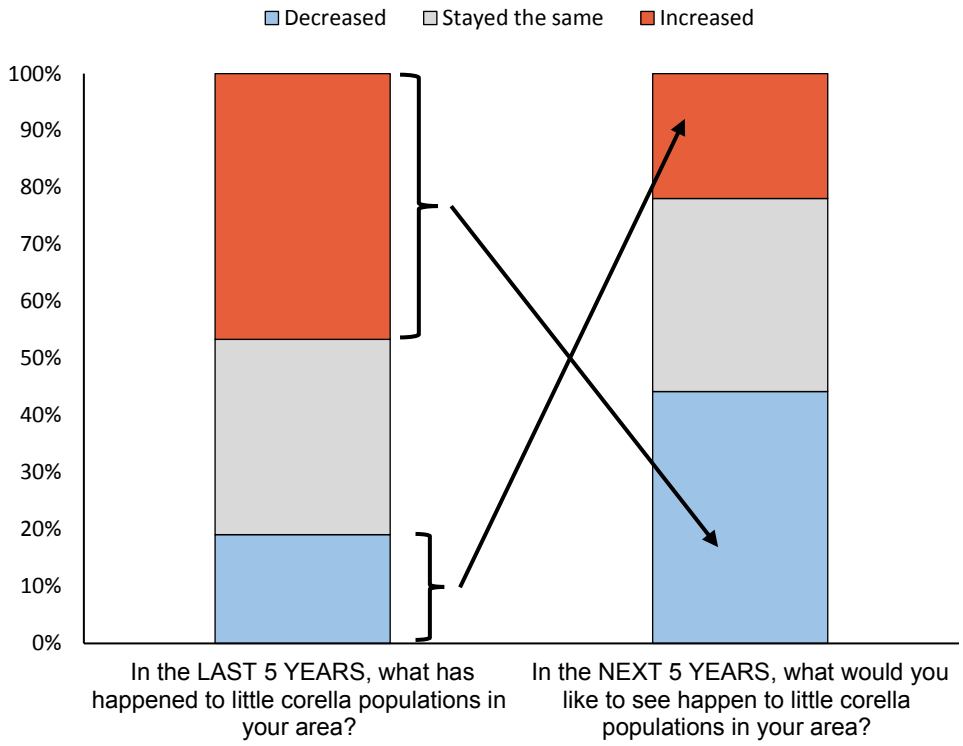


Figure 6 *Survey responses to two statements: 1) In the LAST five years, what has happened to little corella populations in your area? 2) In the NEXT five years, what would you like to see happen to little corella populations in your area?*

Sample sizes were n = 1,152 for statement one and n = 1,167 for statement two. Arrows indicate the opposite trends in recent experience and future expectation

- We tested this trend statistically and found a **strong negative association** between what respondents experienced with little corella populations in the last five years and what they would like to see have in the next five years[i]
- As expected, **strong seasonal trends** in little corella presence were also captured by the survey; these data are presented in Figure 7
- Most respondents reported very few interactions during the cooler months, whereas most people reported **noticing little corellas on a daily basis** during summer (56%, n = 480)[j].

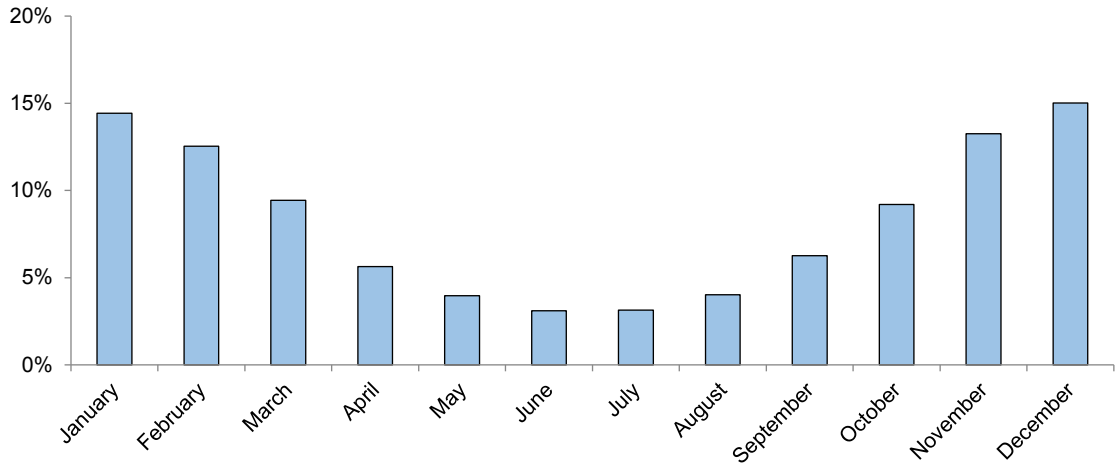


Figure 7 *Frequency of little corella site visits among month*

Sample size was 973 respondents and 4,057 monthly observations

[i] Pearson Chi-Square test of association between two categorical variables (278.121, df = 1, P < 0.001); Phi test for affect size (-0.695, P < 0.001)

[j] Other responses to frequency of sighting during summer were: *every few days*: 20% (n = 175); *weekly*: 7% (n = 62); *every few weeks*: 8% (n = 69); *less often*: 8% (n = 68)

Management of little corellas in South Australia

- Most respondents (66%, n = 831) agreed that there is **a lot of conflict** about the management of little corellas[k]. Few respondents disagreed with this sentiment (9%, n = 117)[l]
- Little corella management was perceived as the **responsibility of all stakeholders**, with 33% (n = 304) of respondents citing *everyone involved* should take responsibility. Individuals and local communities alone had little perceived responsibility. **Local government was an important agency** (24%, n = 224). *No-one*, indicating no management is necessary, was also cited frequently; see Figure 8

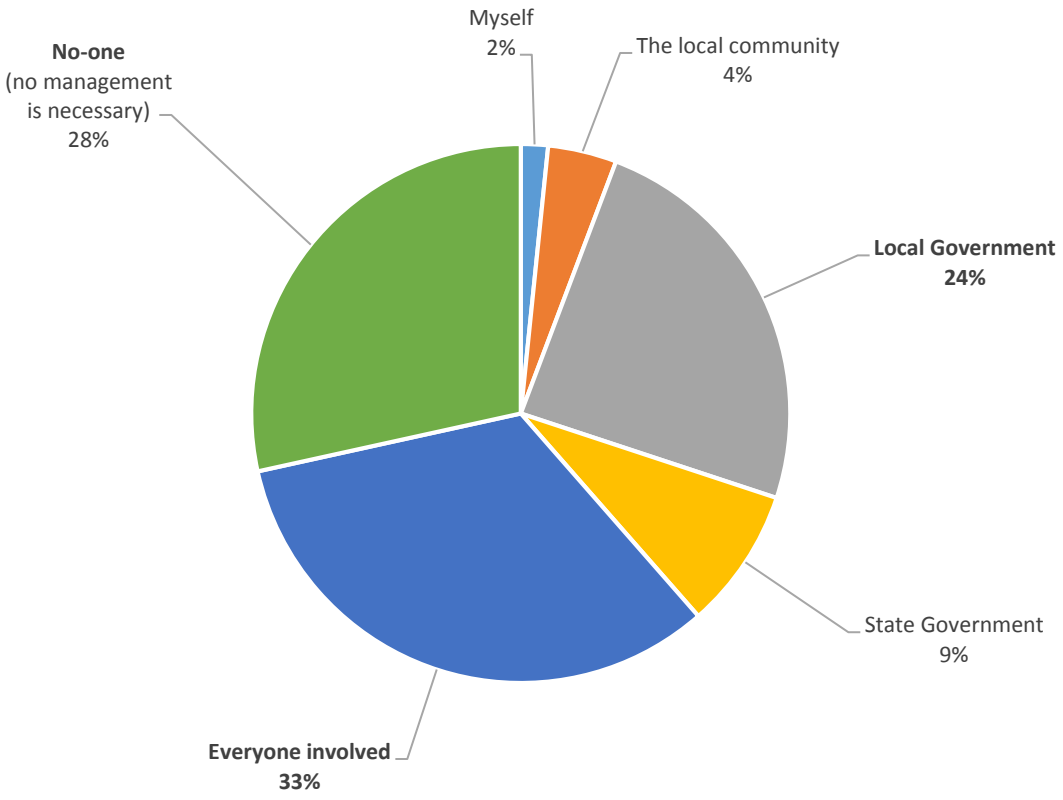


Figure 8 *Agencies considered responsible for little corella management by survey respondents*

Sample size was 921 respondents

[k] They selected "slightly agree", "agree", or "strongly agree"

[l] They selected "slightly disagree", "disagree", or "strongly disagree",

- We gauged survey participants' level of **support or opposition** and perceived **effectiveness or ineffectiveness** to a series of little corella management actions, presented in Table 5

Table 5 *Little corella control measures for which level of support or opposition and perceived effectiveness or ineffectiveness was gauged in the survey*

CONTROL ACTION	CONTROL DESCRIPTION
Falconry	Using birds of prey to scare little corellas to other sites
Spotlighting	Using spotlights to scare little corellas to other sites
Lasers	Using lasers to scare little corellas to other sites
Noise-generating devices	Using noise to scare little corellas to other sites
Trapping and gassing, lethal control	Destroying little corellas to reduce flock size
Shooting to deter flocks, lethal control	Shooting a small number of little corellas to scare flocks to other sites
Habitat modification, increase shrubs	Making sites less attractive to little corellas by increasing shrubs and reducing lawn
Habitat modification, tree removal	Removing trees that little corellas roost in
Do nothing	No management actions
Education program	Developing education materials to increase acceptance of little corellas
Encourage alternate sites	Identify suitable sites and encourage flocks to those areas
Supplementary feeding	Luring little corellas to alternate sites by providing food
Crop netting	Netting crops to reduce impact of little corellas
Asset management, built	Modifying built structures (like antennas) to prevent them from being damaged by little corellas
Asset management, water	Modifying water troughs to prevent access by little corellas

- In terms of support for different management actions, 68% of respondents supported[m] little corellas being **encouraged to alternate sites** (36% of respondents were *highly supportive* of this particular action). Other actions with more support than opposition were: modifying built structures (60%); education (58%) and supplementary feeding (53%); see Figure 9

- Respondents were particularly **opposed to habitat modification involving tree removal**, over 80% of participants were opposed to this action (*highly opposed*: 60%; *opposed*: 14%; *slightly opposed*: 7%). Many participants were equally **opposed to lethal actions**, with 63% of respondents opposed to trapping and gassing and 62% opposed to shooting to deter flocks

- Another poorly-supported action was use of noise-generating devices (51% of respondents were opposed[n]), and 49% of respondents were **opposed to *do nothing***, indicating their support of some action

- Fewer people engaged with the associated survey question about **perceived effectiveness** of management actions, see Figure 10. On average, 165 fewer responses[o] were recorded for this question than for the previous one about support for control actions. Considerable ambiguity was also recorded within the responses (i.e. a high percentage of *neutral* responses), indicating that the relative **effectiveness of various control actions is poorly known** or understood within the community. Increasing education around management options will likely increase knowledge and acceptance of management activities, and NRM Boards or other groups may be effective in this role

- The space between actions that are acceptable to the community and the demonstrated effectiveness of various actions should **provide a focus area for managers**, including in any education actions. For example, falconry was lo 49% of survey respondents, but 41% of respondents rated its effectiveness as *neutral*. Using falconry to create a "landscape of fear" for little corellas is very expensive, the effects are temporary, and the action is generally considered to be unfeasible (e.g. Temby 1999). Scare birds and retail kites (Photo 4) are also generally ineffective because little corellas quickly become habituated to them

Photo 4 *In Aldinga a roof-mounted scare bird sits adjacent to a tree with little corella damage, illustrating their ineffectiveness for long-term management*

[m] They selected "slightly supportive", "supportive", or "highly supportive"

[n] They selected "slightly opposed", "opposed", or "highly opposed"

[o] ±1.0, n = 15 (matched categories), the range was 157-169 fewer responses to the question about perceived effectiveness than to the associated question about support for little corella control actions

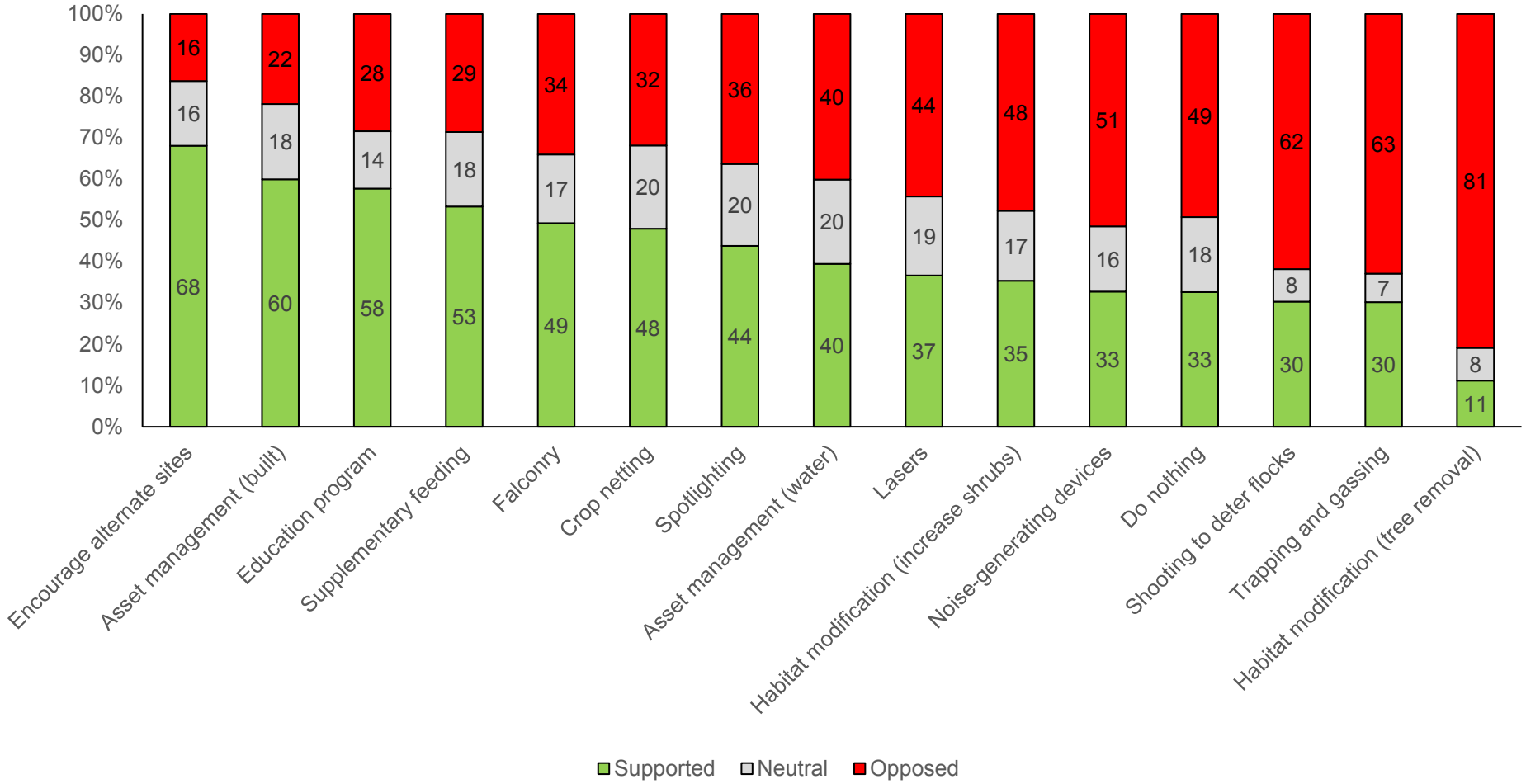


Figure 9 *Survey participants' support and opposition of little corella management actions*

The sample sizes were Encourage alternate sites: n = 873; Asset management (modify built structures): n = 871; Education program: n = 870; Supplementary feeding: n = 870; Falconry: n = 884; Crop netting: n = 873; Spotlighting: n = 877; Asset management (modify water access): n = 872; Lasers: n = 871; Habitat modification (increase shrubs): n = 868; Noise-generating devices: n = 876; Do nothing: n = 861; Shooting to deter flocks: n = 877; Trapping and gassing: n = 881; Habitat modification (tree removal): n = 870

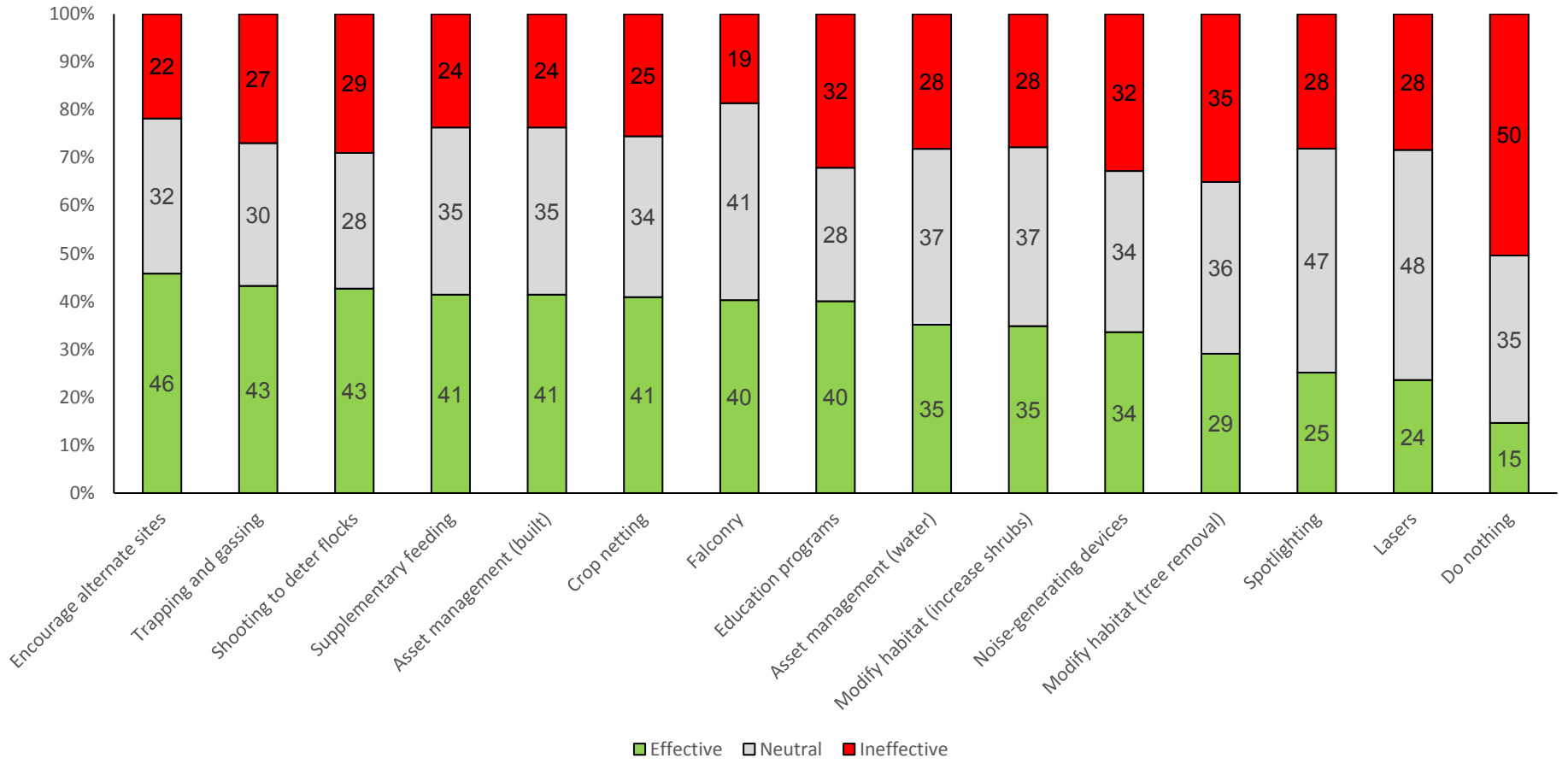


Figure 10 *Survey participants' perceived effectiveness and ineffectiveness of little corella management actions*

The sample sizes were Encourage alternate sites: n = 707; Trapping and gassing: n = 712; Shooting to deter flocks: n = 710; Supplementary feeding: n = 705; Asset management (modify built structures): n = 705; Crop netting: n = 706; Falconry: n = 715; Education program: n = 704; Asset management (modify water access): n = 703; Habitat modification (increase shrubs): n = 709; Noise-generating devices: n = 717; Habitat modification (tree removal): n = 705; Spotlighting: n = 712; Lasers: n = 712; Do nothing: n = 704

Little corella sites across South Australia

- As part of the public survey, South Australians identified over **2,340 little corella sites** across South Australia. See sites in the map below, Figure 11
- **Recreational parks** represented 28% of primary sites identified by survey respondents, and **schools** (10%) and **sporting ovals** (7%) were also commonly identified sites
- Large clusters of sites were recorded within the Adelaide metropolitan area, Mount Lofty and Fleurieu Peninsula region (including Kangaroo Island), along the River Murray from Wellington to Renmark, in the Upper and Lower South-East (Keith to Mount Gambier) and Mid and Far North sites ranged from Gawler to Coober Pedy
- Two survey respondents reported **little corellas sites on Eyre Peninsula**, where they have been reported previously (in 2001[p]). These respondents correctly identified different bird species in the survey, and the reported sites were typical of little corella habitat (recreational reserves and a school in Tumby Bay and a caravan park in Port Lincoln). However, local experts have not observed little corellas on the Eyre Peninsula, and know of no recent record of little corellas in the region (G. Kerr, pers. comm. 2016)
- Generally, survey participants demonstrated good bird identification skills for sulphur-crested cockatoos and galahs (84% and 89% correctly identified, respectively). Little corellas were identified correctly by 78% of respondents and long-billed corellas were less successfully identified, with 62% correct (15% were unsure and 22% incorrect)
- Fourteen people mentioned long-billed corellas in their survey responses. Places where small numbers of long-billed corellas were recorded (during all phases of this project) co-occurring within little corella flocks included: metropolitan Adelaide (parklands, Torrens River, Urrbrae), Mount Barker, Mylor, Old Noarlunga, Noarlunga, and Willunga. Large flocks of long-billed corellas mixed with little corellas were reported in the South East. One report was that **90% of corellas in Naracoorte were long-billed corellas**
- Long-billed corellas are native to the Lower South East in South Australia, but little corellas seem newly arrived to some areas there, one project participant mentioned that, "*We already had long-bills, but we didn't get little corellas in Millicent until we got the new grain bunker*"

Photo 5 *Grain stores and bunkers provide food resources for little corellas, many major facilities like this one in Tailem Bend will have ongoing little corella control programs; image from Google Earth*

[p] Species list for NRM Region Eyre Peninsula, South Australia (2011). Australian Government, Department of Sustainability, Water, Population and Communities

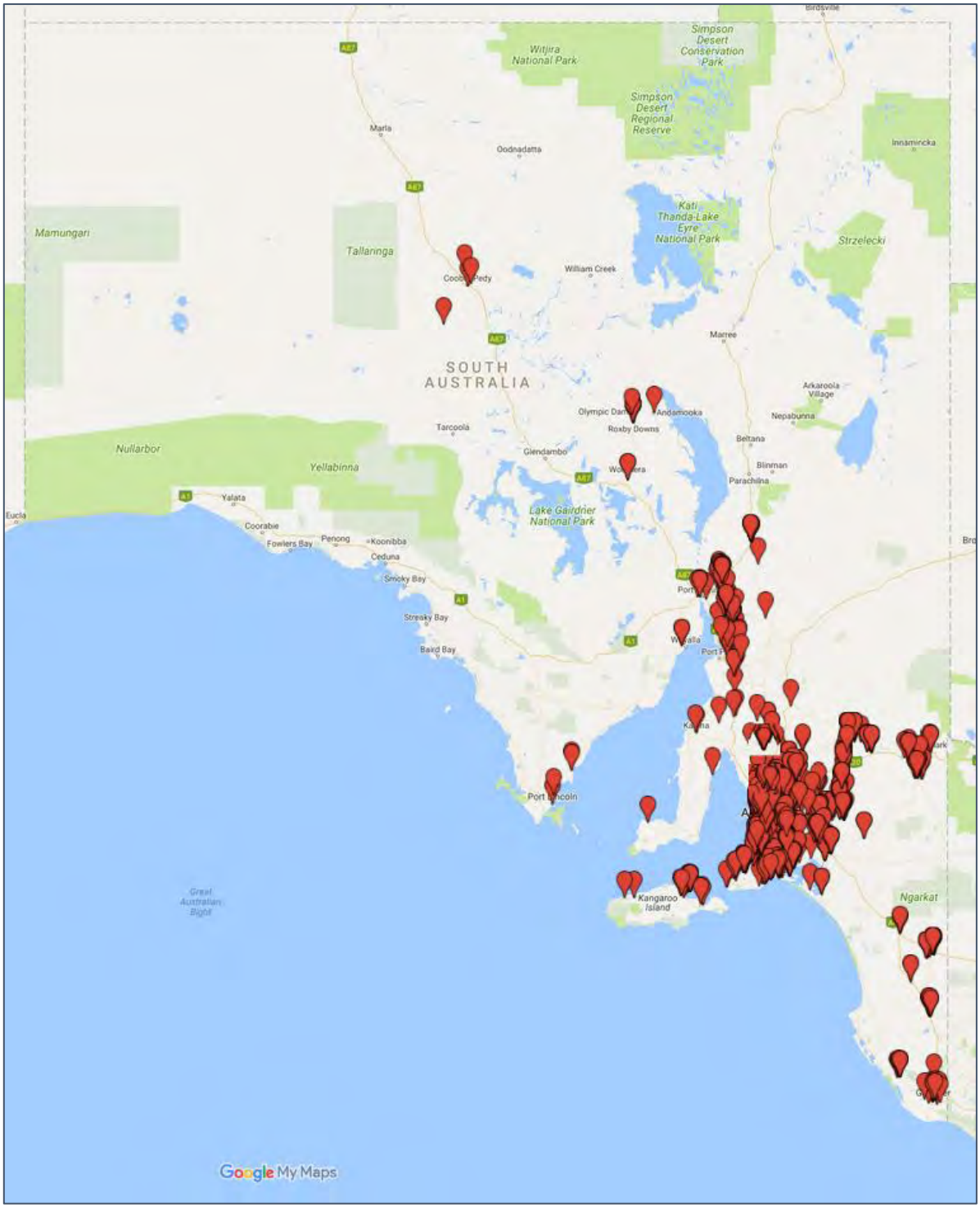


Figure 11 *A map of little corella sites in South Australia, nominated through our community survey of 1,270 people*

Sites were placed as close as possible to the locations described by survey respondents. For privacy reasons, private residences were mapped to the street described rather than on an actual house. An interactive version of this map is available at: http://www.discoverycircle.org.au/projects/little-corellas/

Little corella acceptance capacity

We used participant responses to a series of statements about a flock of little corellas around their house to **generate a measure of each individual's acceptance capacity**. On a 7-point Likert-type scale from *strongly disagree* to *strongly agree*, participants selected their response to 12 statements:

1. *I would enjoy seeing the little corellas*
2. *I would enjoy hearing the little corellas*
3. *I would think that people should learn to live with little corellas*
4. *The little corellas would make me feel close to nature*
5. *I would be concerned about the noise of the little corellas*
6. *I would be concerned about damage to plants by the little corellas*
7. *I would be concerned about damage to property by the little corellas*
8. *I would be concerned about the cost of fixing damage by little corellas*
9. *I would be concerned about diseases spread by little corellas*
10. *I would want the little corellas to be removed*
11. *I would try to scare the little corellas away*
12. *The only good little corella is a dead one*

We conducted a factor analysis to help us understand variations in the way people had responded to these statements. This analysis helped us to identify **two underlying factors** that can be used to **understand how people feel about little corellas:**

- **FACTOR 1: CONCERN ABOUT IMPACT OF LITTLE CORELLAS**
  - This factor relates to concerns with impacts and management associated with little corellas, and 47% of the variance in our data was explained by this factor
  - Survey respondents with **HIGH SCORES** on this factor typically agreed with these statements:

    I would be concerned about damage to property by the little corellas

    I would be concerned about the cost of fixing damage by little corellas
  - Survey respondents with **LOW SCORES** on this factor typically agreed with this statement:

    I would think that people should learn to live with little corellas
- **FACTOR 2: INTRINSIC-VALUE OF LITTLE CORELLAS**
  - This factor relates to loving little corellas and enjoying them as part of nature, and 23% of variance in our data was explained by this factor
  - Survey respondents with **HIGH SCORES** on this factor typically agreed with this statement:

    The little corellas would make me feel close to nature
  - Survey respondents with **LOW SCORES** on this factor typically agreed with this statement:

    I would want the little corellas to be removed

Rather than disliking little corellas, decreased acceptance of little corellas typically stemmed from **frustrations or concerns relating to their impacts and management** (Factor 1). People who scored high on this factor were concerned about damage to property and plants, the cost of damage and the noise, they also wanted little corellas removed or scared away. In contrast many people reported in the survey that they **loved little corellas**, and they held intrinsic values about little corellas (Factor 2). These **respondents enjoyed seeing and hearing little corellas**, and little corellas helped them to feel close to nature. We found that:

- As **experience of impacts increased, general opinion of little corellas decreased**
- Impacts increased with an increase in **little corella numbers** in the last five years
- People with high concern for impacts want the little corella population to decrease in the next five years
- Males typically scored higher concern for impact scores
- No moderate or strong correlations and no significant differences occurred between the intrinsic-value factor and most other measures, suggesting that this factor is relatively stable; **if people hold intrinsic value for little corellas, it may be difficult to change this value** (see Appendix 2)

Opinions about management actions by factor groups

We compared the median **level of support** for different little corella management actions among three groups:

1. *All survey respondents together*
2. *Respondents concerned about impacts of little corellas (Factor 1)*
3. *Respondents that intrinsically value little corellas (Factor 2)*

This analysis enabled us to determine which actions are likely to be **widely accepted, tolerated or contentious within diverse local communities** (i.e. people within communities experience little corellas differently). We generated an overall community ***support index*** for each control measure. The support index is a score out of 100 (presented in Table 6 as a percentage) based on the combined level of support from the three groups. The support index was calculated by adding the median scores of each group and converting the result into a percentage. Control measures with high percentages are likely to be well supported within the community whereas those with low percentages are likely to be opposed. Key findings were:

- **Benign actions received broad support** (support index greater than 60)
- **Encouraging alternate sites** (i.e. creating sacrificial areas away from problem sites) was supported by all groups, and "**do something**" was also strongly supported (i.e. little corella management is wanted)
- Both **effective and ineffective benign** activities were supported
- Neutral support was universal for increasing shrubs and managing water assets (effective measures)
- **Lethal control measures were contentious**; overall, survey respondents were highly opposed and, as expected, people concerned about little corella impacts were more supportive of these measures than were people who value the birds intrinsically
- **Tree removal is unacceptable to the community**

Table 6 *Support for different management actions for three groups of people: all survey respondents, survey respondents concerned about the impacts of little corellas (Factor 1), and survey respondents who intrinsically value little corellas (Factor 2)*

Median response on a scale from highly opposed to highly supportive is given for each group (i.e. from highly supportive to highly opposed for each management action) and the sample size is provided in parentheses below the median response

*Actions are ranked from most supported (towards the top of the table) to least supported (the lower rows in the table) based on a "**support index**"; the support index was calculated by adding the median scores of each group and converting the result into a percentage.*

ACTION	ALL SURVEY RESPONDENTS	FACTOR 1 CONCERN ABOUT IMPACT	FACTOR 2 INTRINSIC VALUE	INTERPRETATION	SUPPORT INDEX
Encourage alternate sites	Supportive (863)	Slightly supportive (401)	Supportive (390)	All respondents, respondents concerned about the impacts of little corellas (Factor 1), and respondents with intrinsic value for little corellas (Factor 2) typically **supported encouraging alternate sites**	**81%**
Do something	Neutral (852)	Highly supportive (399)	Slightly supportive (383)	Overall the survey respondents were **neutral**, while both respondents concerned about the impacts of little corellas (Factor 1) and respondents with intrinsic value for little corellas (Factor 2) typically **supported doing something.**	**76%**
Falconry	Neutral (869)	Supportive (406)	Slightly supportive (391)	While overall the survey respondents were neutral, both respondents concerned about the impacts of little corellas (Factor 1) and respondents with intrinsic value for little corellas (Factor 2) typically **supported falconry**	**71%**
Supplementary feeding	Slightly supportive (861)	Slightly supportive (398)	Slightly supportive (389)	All respondents, respondents concerned about the impacts of little corellas (Factor 1), and respondents with intrinsic value for little corellas (Factor 2) typically **supported supplementary feeding**	**71%**
Asset management, built	Slightly supportive (862)	Neutral (401)	Slightly supportive (389)	Overall the survey respondents and respondents with intrinsic value for little corellas (Factor 2) were typically **supportive of managing built assets**, while respondents concerned about the impacts of little corellas (Factor 1) were typically **neutral**	**67%**
Spotlighting	Neutral (866)	Slightly supportive (404)	Neutral - Slightly opposed (390)	Overall the survey respondents were typically **neutral**, while respondents concerned about the impacts of little corellas (Factor 1) were typically **supportive** of spotlighting, and respondents with intrinsic value for little corellas (Factor 2) were typically slightly **opposed**	**64%**
Lasers	Neutral (860)	Slightly supportive (403)	Neutral (384)	Overall the survey respondents and respondents with intrinsic value for little corellas (Factor 2) were typically **neutral**, while respondents concerned about the impacts of little corellas (Factor 1) were typically **supportive of using lasers**	**62%**

ACTION	ALL SURVEY RESPONDENTS	FACTOR 1 CONCERN ABOUT IMPACT	FACTOR 2 INTRINSIC VALUE	INTERPRETATION	SUPPORT INDEX
Education program	Slightly supportive (861)	Slightly opposed (399)	Slightly supportive (389)	Overall the survey respondents and respondents with intrinsic value for little corellas (Factor 2) were typically **supportive**, while respondents concerned about the impacts of little corellas (Factor 1) were **opposed to education**	**62%**
Crop netting	Neutral (864)	Neutral (401)	Slightly supportive (391)	Overall the survey respondents and respondents concerned about the impacts of little corellas (Factor 1) were typically **neutral towards crop netting**, while respondents with intrinsic value for little corellas (Factor 2) were typically **supportive**	**62%**
Habitat modification, increase shrubs	Neutral (858)	Neutral (400)	Neutral (386)	**All respondents, respondents concerned about the impacts of little corellas (Factor 1), and respondents with intrinsic value for little corellas (Factor 2) were typically** neutral towards increasing shrubs	**57%**
Asset management, water	Neutral (862)	Neutral (401)	Neutral (390)	All respondents, respondents concerned about the impacts of little corellas (Factor 1), and respondents with intrinsic value for little corellas (Factor 2) were typically **neutral towards managing water assets**	**57%**
Noise-generating devices	Slightly opposed (863)	Neutral (401)	Neutral (389)	Overall the survey respondents were typically **slightly opposed**, while both respondents concerned about the impacts of little corellas (Factor 1) and respondents with intrinsic value for little corellas (Factor 2) were typically **neutral towards using noise-generating devices**	**52%**
Trapping and gassing, lethal control	Highly opposed (870)	Slightly supportive (405)	Opposed (392)	Overall the survey respondents and respondents with intrinsic value for little corellas (Factor 2) were typically **opposed**, while respondents concerned about the impacts of little corellas (Factor 1) were typically **supportive of using lethal population control**	**38%**
Shooting to deter flocks, lethal control	Highly opposed (866)	Slightly supportive (403)	Opposed (390)	Overall the survey respondents and respondents with intrinsic value for little corellas (Factor 2) were typically **opposed**, while respondents concerned about the impacts of little corellas (Factor 1) were typically **supportive of using lethal deterrents**	**38%**
Habitat modification, tree removal	Highly opposed (860)	Opposed (400)	Highly opposed (386)	All respondents, respondents concerned about the impacts of little corellas (Factor 1), and respondents with intrinsic value for little corellas (Factor 2) were typically **opposed to tree removal**	**19%**

Community workshops

In the workshops the modelling software enabled participants to **articulate diverse views** and observations (social, ecological, economic) pertaining to little corellas and helped us to facilitate **complex discussions around the issues**. Comments supporting the value or approach of the workshops, the complexity of the issue, changing opinions and other observations are detailed in Appendix 3.

The model created in each of the nine workshops also reflected the priorities and context or experiences of the participants, so although overlap in some themes occurred among workshops, **new themes also emerged**. For example, in a workshop in Onkaparinga we discussed the acceptance of little corellas and factors leading to sites becoming problematic (a social focus), whereas in one workshop in The Flinders Ranges Council area, considerable attention was given to the effectiveness of different controls (a management focus). An example of a model built during one workshop is presented in Figure 12. In addition to broad community participation, members of at least seven local councils, including two local mayors, were involved in the workshops. All models and instructions on the modelling are available online at: http://www.discoverycircle.org.au/projects/little-corellas/community-models/

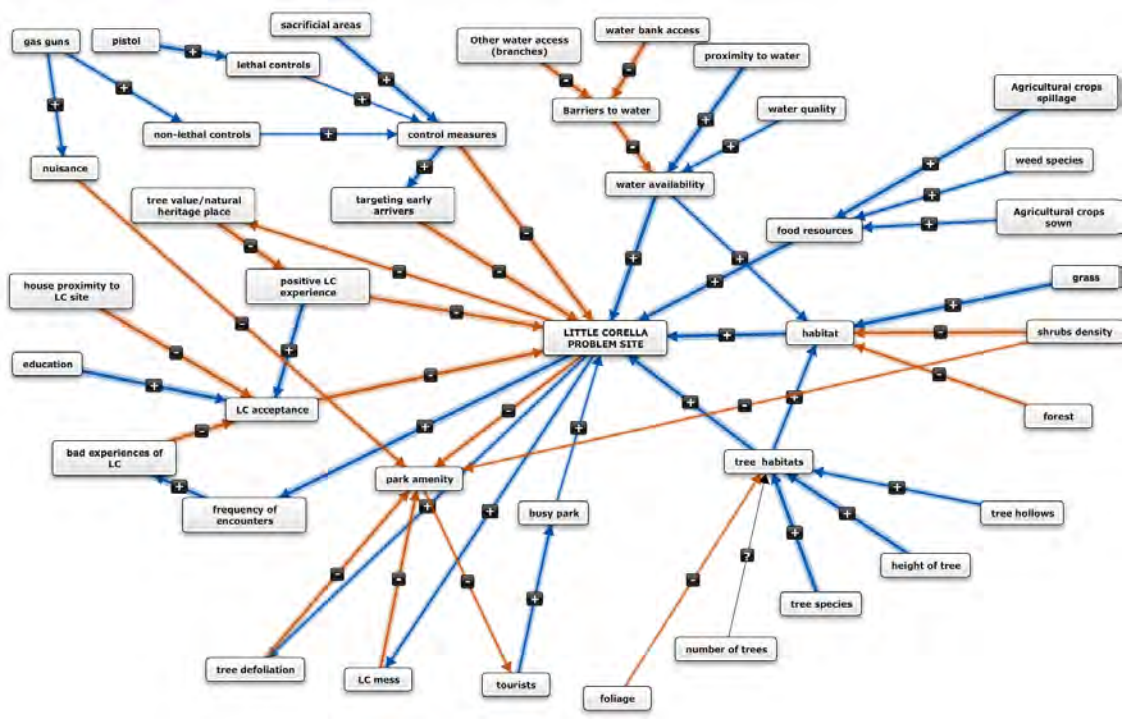


Figure 12 *A model created during a little corella community workshop using the Mental Modeler software*

Arrows indicate the connection, direction, the type and strength of the relationship between components. Each connection occurs between two components only, the direction is indicated by the arrow (e.g. "water availability" leads to a "little corella problem site"), the type of relationship can be positive or negative and the strength is indicated by line. Detailed instructions on using the software are here

Key themes and insights from the workshops

The nature of problem sites

Problem sites comprised isolated locations, a series of neighbouring sites or diffuse problem zones (e.g. corridors of sites along the River Murray). During the warmer months the experience of problems associated with little corellas can be ongoing (i.e. for people living adjacent to a problem site) and/or associated with a particular event – such as a ceremony in a memorial garden or the Mannum Hot Rod Show; **communities fear the loss or disturbance of their events** by little corella presence. In addition to seasonal inundations and large flock sizes, conspicuousness of little corellas is enhanced by their use of high profile public spaces (such as schools or recreation parks), which increases public encounters (and conflict) and awareness of little corellas generally.

Terminology is a barrier

We found **considerable confusion and misuse of terms** associated with little corella management. We found terms such as "cull" and "extermination" (inferring large-scale destruction and extinction of little corellas) were interchanged for targeted lethal deterrents (destroying a few birds to move a flock). "Scout birds" was also used widely; we do not support the use of this term because it implies that a few birds investigate sites and report back to the flock to inform their movements. We prefer the terms "early bird" or "call bird". Whatever the context (discussion, report, correspondence) it is important to define clearly all terms.

Communication is a barrier

Many people didn't understand wildlife management actions, the complexity of management issues, the justification for various approaches, or the problems experienced by councils. The costs of management options were also poorly understood. One cost relayed to us was for $24,000 to destroy 1,500 birds using trapping and gassing. The little success and limited effect of such an exercise coupled with the high cost would be useful information for a public wanting action. The exorbitant costs of using falconry should also be released in order to increase public understanding of this option and the costs (many people support the idea of this action, but have no understanding of the cost or temporary nature of any effect produced).

We also noted that understanding of lethal deterrents was low. Often people were opposed to lethal deterrents and considered them to be similar to lethal population control measures (like trapping and gassing birds). We found that **people changed their minds about the use of lethal deterrents** during our workshops. Comments from workshop participants suggested that they changed their minds for two main reasons. First, workshop participants better understood the complexities of little corella management. Second, workshop participants better understood the use of lethal deterrents, particularly how lethal deterrents can be used in conjunction with non-lethal measures (e.g. spotlighting or noise-generation) to increase the effectiveness of the non-lethal measures. For example, if a few birds are shot during an initial spotlighting effort to disrupt a flock of little corellas, subsequent spotlighting efforts with no shooting will likely be more effective at disrupting the flock (as birds associate the spotlighting with the shooting). Further discussion also brought to light that the careful use of lethal deterrents may help reduce the overall numbers of birds being destroyed (i.e. by avoiding lethal control measures). Thus, the use of lethal deterrents is likely to receive more support from the community than our survey results suggest, but only where lethal deterrents are used to increase the effectiveness of non-lethal measures, where the **strategic approach is understood by the community**, and where lethal deterrents are clearly differentiated from lethal controls.

Local councils want support and co-ordinated action

Many councils feel that they need to be acting on little corellas, and know that the public want action. They want their activities to be meaningful and effective, but they're not always sure about what to do, what works, and what strategic approaches to take. Many councils have worked in isolation to eventually learn the same lessons; they may react as a problem arises and enact ad-hoc trials of different approaches to manage little corellas. Some councils were curious about what other local councils were doing. They have **no organised way of sharing resources or knowledge, or coordinating responses** among agencies, and many supported the notion of a state-wide strategy. Many councils invest considerable resources into little corella management and have detailed knowledge of their management (e.g. Figure 12), but little reporting, data collection or monitoring occurs. Managing time (field staff) and public expectations are key challenges for some councils. Councils also want residents to know how complex wildlife management is, and for the public to take ownership of the issue.

Little corella habitat suitability models

For an abundant species, surprisingly little is understood about the mix of landscape characteristics that influence the distribution of little corellas. The aim of this habitat modelling was to identify these landscape features and drivers of little corella distribution, and to understand why little corellas favour certain areas in South Australia. This information should help inform future management strategies.

- We used observations and insights of citizen-scientists collated from the ***Little Corellas*** project to inform our analyses and merged these with observations of little corellas from *BirdLife Australia Second Atlas*. To our knowledge this is the **first time that habitat suitability models** have been generated for the little corella
- We created two habitat suitability models for little corellas: a state-wide **South Australian model** and a **Mounty Lofty Ranges model.** The second model was necessary because the landscape features of this region are generally uncharacteristic of the rest of the state

Results suggest that little corella habitat was generally characterised by the presence of one or more of the following habitat features: 1) *river red gums*; 2) *major creek lines*; 3) *irrigated green space*; and 4) *pine trees*. However, **depending on where you are in South Australia**, the relative importance of these landscape features differed. Interestingly, although **grain silos may exacerbate** existing little corella issues at a local scale, they were found not to be a strong determinant of little corella distribution in our models.

We believe this study is first to consider the **influence of native vegetation cover and land use type** on little corella distribution. The results of these analyses indicate that:

1. Little corellas **avoid bushland areas** and favour highly fragmented environments
2. **Habitats provided by recreational** (i.e. irrigated green spaces), **agricultural,** and **residential land uses are preferred**

The analyses presented here show us the landscape characteristics favoured by little corellas and provide potentially useful **habitat manipulation strategies**. The relative suitability of the Mount Lofty Ranges, and other temperate agricultural regions, compared to the rest of the state **poses management challenges**; the availability of *irrigated green spaces* is clearly an attractant in these regions[q]. Below we summarise the modelling methods and results. An in-depth description and discussion of the models, including modelling methodology and model limitations, is provided in Appendix 4.

South Australian model

- Little corella input data included 3,069 presence locations (1972−present); Photo panel 4A
- The habitat suitability model is shown in Figure 13; **model performance was good-excellent**
- State-wide, the most important habitat features for little corellas were ***river red gums***[r], ***irrigated green spaces*** and ***major creek lines***. These three variables combined explained 90% of the little corella distribution
- Model results suggest that as distance (m) from nearest *river red gum*, *irrigated green space* or *major river* increases, the **probability of little corella presence declines** (Appendix 4)
- *Pines* were less important. Probably because they are planted less frequently in regional South Australia, particularly in the state's pastoral zones
- Unsurprisingly, as human population density increased so did the occurrence probability of little corellas. This trend is likely to reflect the increased availability of food and water resources within human-dominated environments
- Some uncertainty exists about the current status of little corellas on the Eyre Peninsula. Our habitat models suggest that the habitat conditions are favourable for their establishment there

[q] The predicted habitat suitability values at some of the sites shown in the maps may not be as expected because of two factors: 1) some input datasets are known to be incomplete (e.g. *irrigated green spaces*, *red gums*) and, consequently, information on one or more of these habitat variables is not available at all sites; or 2) other site specific factors not captured by the habitat models influence little corellas at these sites. One or both of these factors will influence the final model predictions. These maps should be considered as indicative of potential little corella distribution only

[r] *Eucalyptus camaldulensis*

Mount Lofty Ranges model

- Little corella input data included 718 presence locations (1972−present); Photo panel 4B
- The habitat suitability model is shown in Figure 14; model **performance was good-excellent**
- Two-thirds of little corella distribution within the Mount Lofty Ranges was explained by the availability of, and proximity to, **irrigated green space**. The **probability of little corellas increased** as the distance to the **nearest irrigated green space decreased** (Appendix 4). The availability of these spaces within the region is much greater than for the rest of the state
- **Distance to nearest major creek line** was also a factor in determining little corella distribution within the region. Tall eucalypts are used as roost sites. These trees are often concentrated along watercourses in highly fragmented environments
- The influence of **distance to nearest pine** (*Pinus* sp.) tree on little corella distribution was greater within the Mount Lofty ranges than for the rest of the state. Pine trees[s] are largely confined to agricultural regions of South Australia, especially the Mount Lofty Ranges, so are more readily available. That said, little corellas feed primarily on the seeds of grasses and herbaceous plants. Pine seeds may comprise only a minor dietary component (Higgins, 1999)
- Distance to nearest river red gum was not as an important factor within the region. This species of gum is not confined to watercourses and rivers within the Mount Lofty Ranges, as it is across the rest of the state. Further the diversity of tall, emergent tree species within the region is comparatively higher than for the rest of the state. Therefore the dependence of little corellas on river red gums in this region is likely to be less than in other areas of the state

[s] *Pinus* species

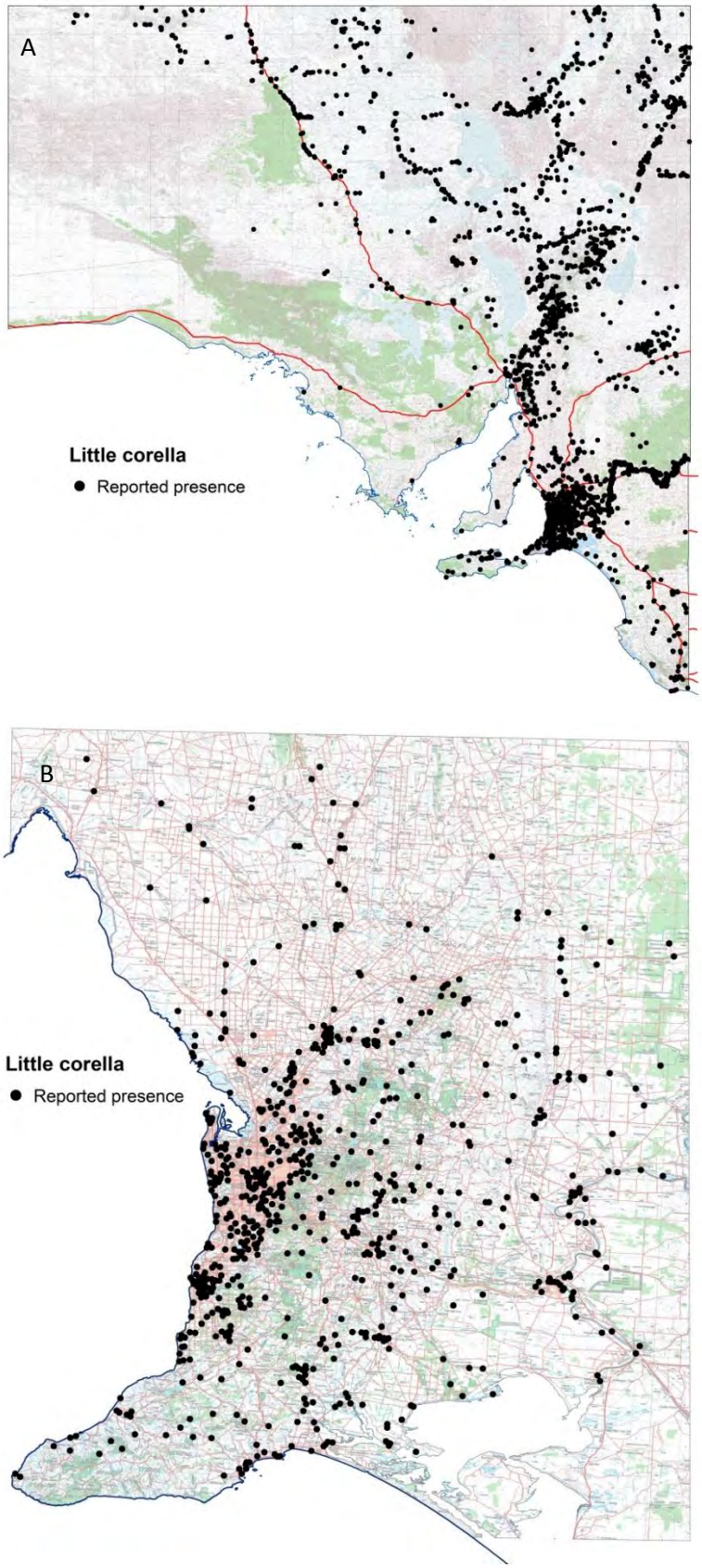
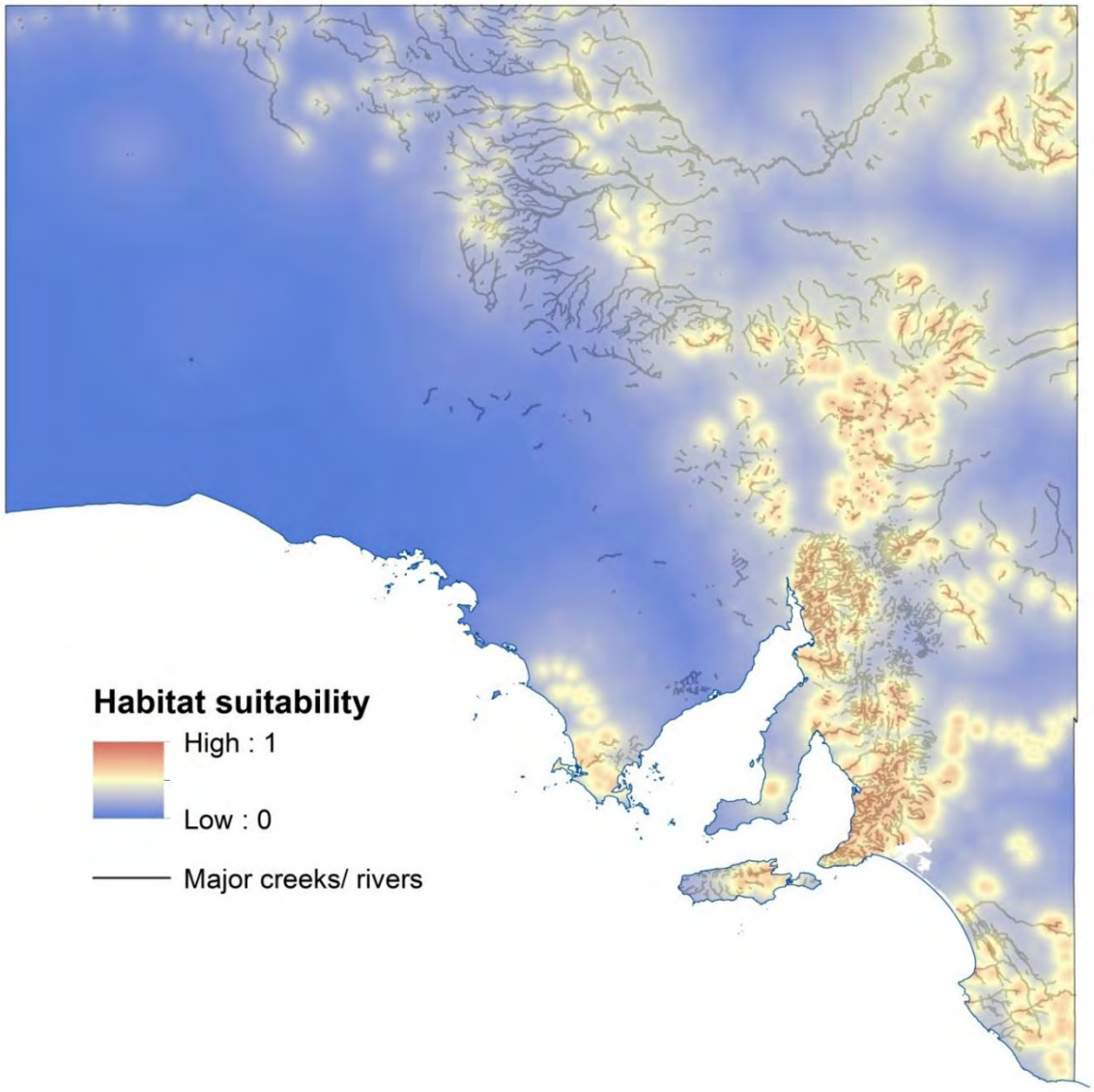


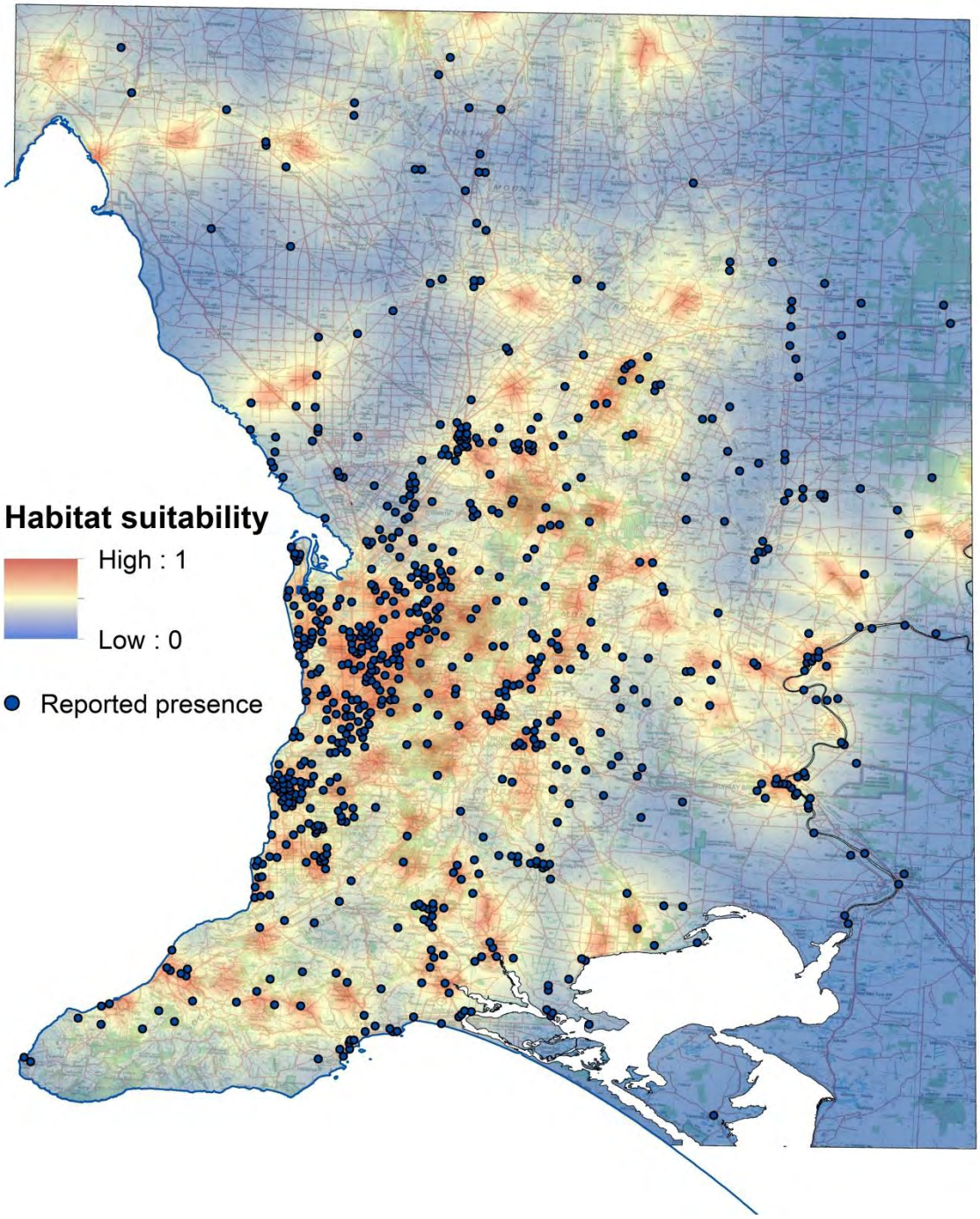
Photo panel 4 *Little corella presence locations across South Australia (A) and for the Mounty Lofty Ranges (B) used to create habitat suitability models*



VARIABLE	RELATIVE IMPORTANCE
Distance to nearest *river red gum tree*[t]	**49.1**
Distance to nearest *irrigated green space*	20.1
Distance to nearest *major creek*	19.2
Distance to nearest *pine tree*	1.1

Figure 13 *Little corella habitat suitability model for South Australia, with the relative importance (%) of each habitat variable to the final model*

[t] Note that "red gum" and "major creek" are highly correlated. This relationship can conflate the relative contribution rankings



VARIABLE	RELATIVE IMPORTANCE
Distance to nearest *irrigated green space*	**59.8**
Distance to nearest *major creek*	23.9
Distance to nearest *river red gum tree*	14.7
Distance to nearest *pine tree*	1.7

Figure 14 *Little corella habitat suitability model for the Mount Lofty Ranges, with the relative importance (%) of each habitat variable to the final model*

Analysis of land use and vegetation fragmentation

Landscape composition is likely to have a significant influence on the distribution of little corellas in South Australia. In separate analyses, we examined the influence of land use and native vegetation cover on little corellas. With regard to land use, we were interested not only in the pattern of land uses (i.e. the number, shape and size of patches), but also the relative influence of competing land uses on little corella occurrence. We are not aware of any similar analyses for little corellas. Because of computational complexity, land use was only considered for the Mount Lofty Ranges subregion.

Summary

- Irrespective of analysis type (i.e. pattern or proportion), **recreation, agricultural and residential land uses** were consistently **the best predictors** of little corella distribution; see Table 7
- Residential areas and agricultural environments are attractive to little corellas because of their diversity of land uses and habitats, as well as the abundance food and water resources
- Recreation areas (i.e. irrigated green spaces), such as ovals, golf courses, and caravan parks, also provide feeding resources
- Interestingly, both the land use and native vegetation cover analyses suggested that:
    - **Little corellas actively avoid bushland areas** (i.e. "Reserve" in Table 7)
    - Little corellas **favour highly fragmented patches of native vegetation** (e.g. vegetation along roads/rivers, surrounding ovals and in council parks and gardens; see Appendix 4)
- Because little corellas avoid large areas of native vegetation **increasing nativeness of existing parkland areas represents a constructive action to reduce site attractiveness** to little corellas
- In terms of landscape pattern, the probability of little corella presence increased with the number of patches of **recreation, agricultural or residential land uses** in surrounding areas (Table 7)
- More recreational land uses (i.e. irrigated green spaces), such as ovals, golf courses, and parks, equates to more potential feeding resources
- As the number of agricultural and/or residential properties within a 1 km radius increases, in general, so does the availability and diversity of these resources. Smaller agricultural holdings are commonly associated with lifestyles and hobby farms. These environments, in particular, provide opportunistic food and water resources for little corellas
- Interestingly, both the land use and native vegetation cover analyses suggested that little corellas actively avoid bushland areas and favour highly fragmented patches of native vegetation (i.e. vegetation along roads/rivers, surrounding ovals and in council parks and gardens). Therefore, increasing the nativeness of existing parkland areas represents a constructive action to reduce site attractiveness to little corellas

Table 7 *Average explanatory power of land use categories surrounding little corella sites*

Average values are based on radii of 1, 3, 6, 9 and 12 km surrounding little corella sites

LAND USE TYPE	EXPLANATORY POWER (%)
Residential	**9.9**
Recreation	**8.5**
Agriculture, livestock, vacant	**5.6**
Industry	2.4
Commercial	1.4
Forestry, horticulture	0.3
Reserve	**0.0**

Favoured by little corellas

Little corellas avoid bushland

Site-specific characters

- Landscape-level habitat characters (distance to creek, river red gum or irrigated green space) and land use (recreational, residential, agricultural and bushland) will predispose different areas to little corella presence across the state, but site-specific characters are also influential. Site characters can **exasperate existing problems**, or **be manipulated to reduce attractiveness of problem sites** to little corellas in conjunction with other activities (i.e. integrated management)
- We looked for commonalities among 144 little corella sites surveyed during the project (individual sites listed in Appendix 5). Key site characters associated with little corella presence were: **extensive exotic lawn areas, access to water, open habitat** (i.e. low tree density, often including pine trees) **and very few shrubs**; see Table 8, Figure 6, Photo panel 5

Table 8 *Characteristics of 144 little corella sites surveyed during the project*

CHARACTER	DESCRIPTION AND MEASURES
Irrigated lawn	• **HIGH OCCURRENCE:** irrigated lawn occurred at 100% of sites • **HIGH COVER:** median score for lawn cover was the maximum of 5 (> 75% cover) • **LOW NATIVENESS**: median score for grass nativeness was 1 (exclusively/almost exclusively exotic species)
Shrubs	• **LOW COVER:** median score for shrub cover: 0 • **LOW NATIVENESS:** median score for shrub nativeness: 0
Trees	• **LOW COVER**: median score for (short) trees < 10 m was 2 (< 5% cover) • **MEDIUM COVER**: median score for (tall) trees > 10 m was 3 (5-25% cover) • **MEDIUM NATIVENESS**: median score for nativeness in short and tall trees was 3 (mixed exotics and natives) • **HIGH OCCURRENCE (PINES)**: pine trees (*Pinus* spp.) were present at 63% of sites • **MEDIUM COVER (PINES)**: median score for *Pinus* spp. was 3: 5-25% cover • **HIGH DAMAGE**: damage to roosting trees such as Norfolk Island pines[u] and native tree species was common. they prune these trees to increase visibility and perceptions of safety, and to maintain good beak condition
Water	• **MEDIUM WATER ACCESS**: an obvious[v] water resource occurred at 50% of sites; a permanent water resource occurred at 39% of sites • **LOW BARRIERS**: fewer than 5% of sites with water had a barrier to the resources (vegetative barrier or another barrier such as dam lining)

Photo 6*Little corellas (indicated by red arrow) roosting in tall trees at the Tailem Bend Ferry Terminal*

This site has a permanent water resource, irrigated green lawn, tall sparse trees and few shrubs – perfect habitat for little corellas

[u] *Araucaria heterophylla*; Norfolk Island pines have a single trunk, and simple symmetrical branching such that damage to these trees has great visual impact (loss of symmetry)

[v] Water resources were only assessed at the immediate site, obscure adjacent resources may have been missed

Ovals with irrigated grass and Aleppo pines are typical little corella sites

Photo panel 5 *Town ovals with irrigated grass and Aleppo pines were typical sites for little corella activity*

A) Two Wells; B) Strathalbyn; C) Cockatoo Valley/Sandy Creek; D) Goolwa; E) Milang; F) Tanunda; G) Wilmington oval

Access to food resources at problem sites

Photo panel 6 *Food resources accessed by little corellas*

A) seeds and bulbs in grass and lawn areas; B) pine nuts, especially from Aleppo pines; C) flower nectar; D) fruits and seeds of olive groves, and other nuts such as almonds; E) spilt grain in farm paddocks and paddock stubble; F) ideal little corella habitat is created by an Aleppo pine windbreak with adjacent paddocks and permanent water accessed via the stock trough (photo F: D. Wingrove)

Access to water resources at problem sites

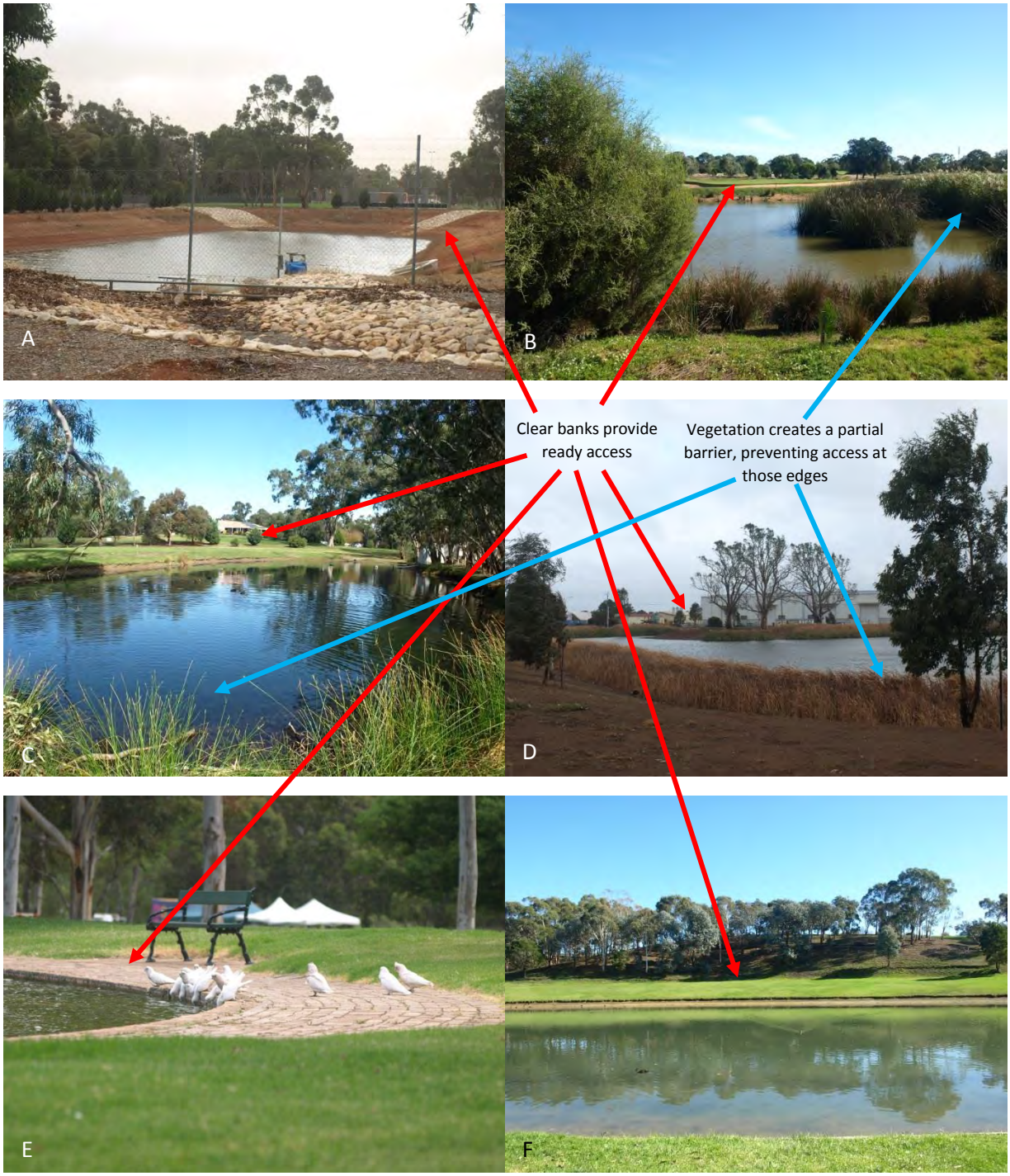


Photo panel 7 *Water resources readily accessed by little corellas*

A) a school dam in Gawler; B) wetlands at an Adelaide golf courses; C) a dam at a golf course in Mount Barker; D) a large water body in the Roseworthy industrial area; E) a lake at Bonython Park in Adelaide; F) a lake at Keith Stephenson Park in Mount Barker. Clear open banks allow ready access to the resource (red arrows), whereas vegetated areas create a partial barrier with minimal effect on site amenity (blue arrows) – these barriers need to be complete (whole) in order to reduce little corella access to site resources

Photo panel 8 *Water resources readily accessed by little corellas*

A) on the banks of the Onkaparinga River; B) the Murray River; C) stock troughs; D) birds drank from this swimming pool in Strathalbyn; E) small puddles on roadsides were used (little and long-billed corellas together); F) small sticks and snags were used to access water at a Strathalbyn park, but it was not the preferred access point

Recommendations for management actions

Integrated management

- Integrated management is vital for managing little corella problem sites. Integrated management should occur at different levels and time frames; while immediate and site-specific actions are needed now, land managers also need to **consider future trends and emerging problems** (e.g. new problem sites or new problem species)
- With unlimited access to resources and a reduction in predators near towns, the population growth of little corellas will continue to increase. Control actions then become a **permanent fixture of management regimes**, and **new problems** will continue to emerge. An integrated approach seeks to reduce problem sites and, in the long-term, reduce the need for management of little corellas (managing the sites, rather than the birds)
- It is important that no action should occur in isolation, but as part of a **cohesive plan**; if little corellas are excluded from some areas, then alternate suitable refuge areas will assist in keeping little corellas away from problem sites. These "sacrificial areas" need to be incorporated into the strategy and good communication among the community is also necessary so that control activities are not undermined or confused
- Managers must **coordinate and target actions at identified problem sites** to make those sites less attractive to little corellas. By **targeting interventions at problem sites** managers avoid spreading resources thinly across a large area with little impact.
- Creating **barriers to resources** is vital and an effective means for reducing problems at targeted sites. Habitat modification (increasing shrubs) and modifying water troughs received better public support compared to some other measures (e.g. lethal population controls or noise deterrents)
- **Increasing "nativeness" of sites** affected by little corellas is key to alleviating little corella pressure, enhancing local biodiversity, and diminishing future threats of over-abundant urban-adapting species thriving in these areas (e.g. Australian white ibis, rainbow lorikeets, noisy minors)
- Irrigated green areas are important for recreation, and modifications need to be meaningful and planned, as well as **sensitive to community needs**
- Enacting integrated management will require **coordination and collaboration within councils and among other agencies and organisations**. For example, within a council it is necessary to have planners and park/landscape managers involved in little corella management, as well as executive support. Council staff will need to liaise with other agencies and organisations to assist and support the integrated management. For example, local Natural Resources Management Boards, schools, golf courses, caravan parks, and other members of the community

1. Creating barriers to roosting and feeding resources

Site managers need to differentiate between problem and non-problem sites and tailor any management strategies appropriately:

Non-problem sites:

- Identify suitable **areas where little corellas are not problematic** "non-problem sites", and designate these areas as "sacrificial" areas where little corellas will not be disturbed

Problem sites:

- **Identify and engage with all stakeholder groups associated with the problem site**, including the local Natural Resources Management Board and local community groups who use the park
- **Identify feeding and roosting resources associated with a problem site**, and **list priority trees** for protection at that site (e.g. special heritage trees, memorial trees and trees at risk from pruning/defoliation by little corellas)
- **Develop an integrated action plan** to disrupt how little corella flocks use the problem site; the plan should include:
    - Revegetation activities to **add screening vegetation**, such as an understory shrub layer, to reduce site attractiveness to little corellas (visual screens decrease the openness of habitat and reduce little corella perceptions of safety – remove a clear view of the surrounding area)
        - Photo panel 9 depicts a park where little corellas are not problematic; it includes spaces for **recreation set amongst islands of vegetation** with well-developed understory, shrub-layers and trees
        - Photo 7 depicts a non-problem site (no management problems exist); little corellas feed on grass areas, but they do not roost there. A native woodland patch that reduces little corella perceptions of safety and limited water access decreases the overall site attractiveness to little corellas for roosting
    - Revegetation activities in an area, including street tree selection, should focus on locally native species. **A council-wide approach to native plant selection** should be adopted
        - **Local native plants are optimal** because native flora and fauna are adapted for local conditions, whereas introduced plant species provide new resources and greater risk of creating new problems (adaptive species learn to exploit new resources and have little competition, leading to increased abundance)
        - Note that if local native plants are not feasible/suitable they can be substituted for **non-native alternatives that mimic the structure and character** (e.g. ornamental hedges, shrubs and/or garden beds) of native vegetation to deter little corellas
    - Increased nativeness includes establishment of a **complex understorey** (grasses, shrubs)
        - Native shrubs reduce the openness of problem sites (vantage decreases) and their attractiveness to little corellas will also decrease
        - Complex understories also enhance biodiversity; the loss of bird biodiversity was of particular concern to the community. Noisy minors are also associated

with open urban parks (sparse trees over irrigated lawn). Once established they dominate and exclude small birds, and they are listed as a national threatening process. Grasses, shrubs and complex tree layers will deter noisy minors and little corellas, and will prevent their attraction to the site initially (i.e. low risk, preventative management)

- Tree cover in the Adelaide metropolitan area is considered to be artificially high because the urban forest has replaced large areas of **low woodlands and shrublands** (Smith, 2010). Low-statured trees and shrubs help create complex layers for wildlife and should be incorporated into revegetation activities

- Although falconry as a control technique is prohibitively expensive and any effects produced are temporary, **predatory birds** do cause unease within little corella flocks and these raptors may be encouraged to problem sites through the provision of low-cost specialised roosting/nesting platforms and hunting perches

    - International resources and tools are available for supplementing raptor habitat (e.g. building nest boxes for falcons), but activities in South Australia will need to target the requirements of local raptor species and should be developed with advice from local bird experts (research, trials and monitoring maybe required)

- **Irrigated grass areas** (including invasive environmental weeds such as kikuyu) should be reduced where possible

    - Schools and councils pay large sums to irrigate turf areas, native lawn alternatives should be used in suitable areas to **replace lawn and decrease water use**

    - Substituting turf for appropriate native perennial ground covers will remove food resources for little corellas, and can alleviate public fears about increased risks of snakes in tall vegetation adjacent to paths

- **Protect important trees at risk** using an electric track system (such as BirdJolt) to stop the use and defoliation of significant trees by little corellas:

    - These systems give a **non-lethal** electric fright to birds that land on it

    - The system can be moved among affected trees and in response to observations and monitoring activities

    - Displaced birds should be monitored to ensure that new roosting areas are suitable (and that the problem is not transferred elsewhere)

    - Temporary netting is also effective for excluding little corellas from trees at risk, including for medium-sized trees (e.g. Morton Bay figs; Hodgens, 2015)

- **For non-tree roosts at problem sites**, such as fences and buildings at the Hewett Primary School and the Strathalbyn Swimming Pool, the electric track system could also be used to deter little corellas from roosting (Photo panel 10)

    - Screening vegetation or other visual barriers (e.g. canvas screens) should also be used to deter birds from these roosts, note that little corellas will exploit areas if small gaps occur in the screens

- **Remove declared weeds, particularly Aleppo pines**, and replace with locally native trees. Aleppo pines were common at little corella problem sites (see Photo panel 11) where they provide rich food and roosting resources
    - The weed potential of *Pinus* species, especially Aleppo pines (*P. halepensis*) in the Mount Lofty Ranges, provides sufficient justification to consider their removal from public and private lands in South Australia. Their role in exacerbating impact of little corellas at problem sites provides even a greater impetus
    - The negative affect of pine removal on yellow-tailed black cockatoos[w] needs to be considered carefully and incorporated into a planned replacement
    - Locally native cone-bearing plants should be included when replacing Aleppo pines
    - Contact the Natural Resources Management Board and other identified stakeholders (e.g. Bird groups) to coordinate their removal and to plan revegetation programs
- Use dense planting of **short statured trees adjacent to agricultural crops** and other open areas to reduce site attractiveness and to protect crops from little corella foraging activities (Jarman, 1986)
    - Visibility at these sites may also be reduced by synthetic screens (hessian, canvas, plastic). The low cost of these materials mean that they can be used to experiment with screen configuration
    - Manage the removal and replacement of Aleppo pines as paddock windbreaks (if not before, then particularly as these trees reach senescence)
- **Use traditional management and control activities** to deter and disrupt little corella flocks in trees at problem sites
    - Non-lethal techniques (such as noise and spotlighting) should be favoured as they are most accepted by the community (bearing in mind that some noise-producing devices can be problematic, particularly when their use is ongoing)
    - Non-lethal techniques can be more effective if reinforced by lethal deterrents. Lethal deterrents should only be used with appropriate permissions and safety considerations, and with careful consideration of community attitudes (see our section about communication barriers, discussed as part of the Community Workshop outcomes) where we discuss how acceptance of lethal deterrents may be increased where lethal deterrents are used to increase the effectiveness of non-lethal measures, where the strategic approach is understood by the community, and where lethal deterrents are clearly differentiated from lethal controls)
    - Avoid trapping and gassing or falconry, which are ineffective (e.g. Temby 1999; also supported by workshop data and other data collected during this study – e.g. on the River Murray some people feed carp to encourage kites that then

[w] *Calyptorhynchus funereus* (listed as Vulnerable in SA)

scare away the little corellas, but noticed little corellas returned when the kites leave)

- Coordinate with landholders to **reduce problems on private land**, and encourage communities to promote urban biodiversity in private gardens (collaborate with NRM groups on these activities), seek and/or promote beneficial collaborations with other groups and programs (e.g. Paddock Tree Project by Trees For Life)
- **Communicate with the public** about actions at problem sites; erect signs about management activities at problem sites
- Identify any **other factors that contribute** to the site being problematic. Specifically, adjacent watering areas
- Monitor and review

Photo panel 9 *Beaumont Common: increasing site nativeness in urban areas also decreases site attractiveness to little corellas*

Revegetation activities that include understory planting can create beautiful urban parks without compromising on a sense of openness and safety. While little corellas may still use the grassed areas, Beaumont Common was not a problem site

Photo 7 *Enfield Memorial Park and Folland Park: a non-problem site*

Managers of the Enfield Memorial Park reported that little corellas visit the site and feed on grass areas, but that no management problem exists at the site. Limited water access and decreased perceptions of safety for roosting there from a native woodland patch (3.2 hectares) likely reduces the attractiveness of this site to little corellas

Photo panel 10 *Non-tree roosts at problem sites*

Problem sites: little corellas roosting on a fence at Hewett Primary School (A) and on steel beams at Strathalbyn Swimming Pool (B)

Aleppo pines should be removed from problem sites, where possible

Photo panel 11 *Aleppo pines (*Pinus halepensis*) were commonly found at little corella sites*

A) the corner of Honeypot and South Road; B) Strathalbyn oval; C) Strathalbyn cemetery; D) Grange golf course; E) North Adelaide golf course; F) new Aleppo saplings at Royal golf course; G) Murray Bridge township; H) Aldinga township; I) Roseworthy university campus; J) windbreak at Old Noarlunga; K) windbreak at Melrose; L) Aleppo corridor at Aldinga; M) Two Wells oval

2. Creating barriers to water resources (lakes, dams, pools, ponds and rivers)

Site managers need to:

Non-problem sites:

- Do not disturb little corella access to water resources at non-problem sites

Problem sites:

- **Identify all stakeholder groups** associated with the problem site
- **Identify drinking/watering resources** associated with a problem site
- Develop an integrated action plan to **restrict access to water resources** at problem site; the plan should include:
    - For problem sites with built banks around the water bodies being used by little corellas, to **increase bank height** (or decrease water level) so the distance from bank to water level is greater than the body length of little corellas (i.e. at least 45 cm; see Photo panel 11, 12)
    - In the workshops some people were concerned that changes to bank levels would affect other birds negatively, but we observed common parkland bird species readily accessing water resources from raised banks; however, galahs are also likely to be negatively affected at problem sites. Generally, high public approval was received for this action **once it was explained**
    - Note that we do not propose the replacement of natural banks with built structures, but recommend the slight modification of existing structures at problem sites as an effective approach
    - When communicating this strategy, it is important to stress that water resources will not be removed, rather that little corella **access to the resource is being constrained**
    - If little corellas are observed using **tree snags in lakes or rivers** to land on and drink from at problem sites, then these structures should be pruned to below the water surface
    - Note that tree snags **should not be removed** (only trimmed below the water surface) because they are important aquatic habitat
    - For lakes and ponds with bare earth banks, a physical barrier to water resources should be created by **planting thick reed vegetation** around the edge
        - Note that vegetative barriers should be complete, small gaps may be exploited
    - If large open earth bank areas are required at problem sites, then other actions should be taken to reduce visibility (openness and clear view) and perceptions of safety near those areas. Adjacent dense tree plantings and screening shrub vegetation or material/synthetic screens to remove a clear line of sight when little corellas are drinking will decrease their perception of safety at the site, and make it a less attractive watering site

- Polyethylene **dam liners** may also provide an effective barrier at dam sites because they are reportedly difficult for little corellas to walk on
- **Swimming pool covers** should be used in problem areas such as at Strathalbyn when the pool is closed (see Photo panel 8D), and used in conjunction with other deterrents
- **Stock trough modifications** can be very effective when targeted correctly; PVC pipe on wire around the rim of a trough creates a spinning edge as little corellas try to land and drink. Water levels could also be adjusted so that distance from edge to water level exceeds little corella body length, i.e. > 45 cm (see Photo 8)
    - Stock troughs near problem sites should be targeted first
    - Trough modifications will be more effective in some areas than in others, in dry areas compared to river sites for example
- **Landscape-level considerations**: little corella problem sites may have an obvious watering point or the resource may be at an adjacent site, or not known
    - See examples of problem sites relative to water resources for Bonython Park (Photo panel 13), University of Adelaide Roseworthy Campus (Photo panel 14A) and Snowtown (Photo panel 14 B-C)
    - For problem sites associated with large rivers (e.g. Mannum, Tailem Bend, Murray Bridge, Loxton, Berri etc.), management activities should focus on problem sites and constraining access to water at those sites via reed plantings and screening vegetation in conjunction with other management activities
- **Access to river water at problem sites** should also be reduced. Problematic sites along rivers have typical little corella habitat (i.e. open areas of exotic irrigated grass, and ready access to water and roosts). Water access should be reduced by reedy vegetation barriers and increased site nativeness (including native shrubs) to decrease perceived safety at the site for drinking (and for feeding on grass areas); see Photo panel 15
- **Monitor and review**

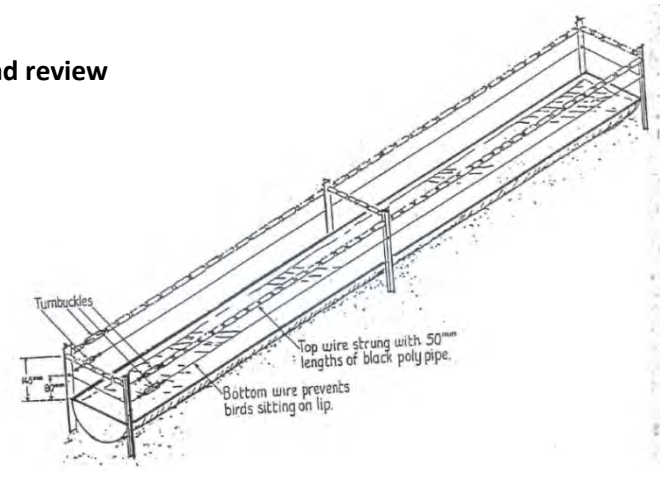


Photo 8 *Trough modification to prevent access by little corellas*

Image from St John (1994)

Increase bank height

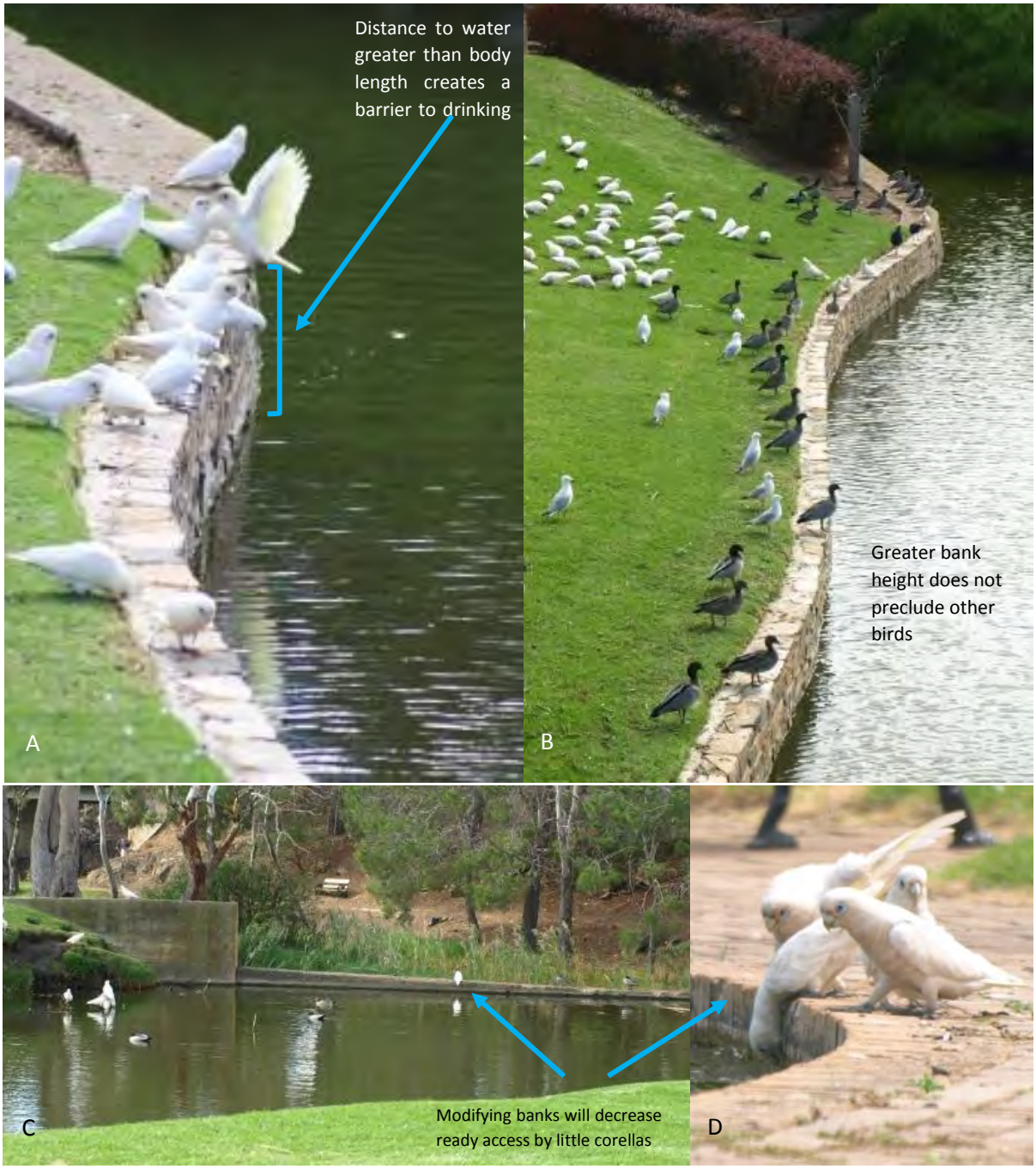


Photo panel 12 *Limit little corella access to water resources by increasing bank height*

A) we watched little corellas repeatedly try to drink water from this high bank, but they were unsuccessful; B) ducks and water fowl used the area and accessed the water from this bank; C) increasing bank height along this levee would reduce water access to little corellas, although snags in the water were also used, they were not preferred and could also be removed as part of an integrated plan; D) a favoured little corella watering resource is within reach at Bonython Park, Adelaide; raising the bank or lowering the water level will exclude little corellas

Target water resources at landscape level

Photo panel 13 *Bonython Park: an emerging resident population of little corellas*

A) West Terrace ovals near Adelaide High School, and the water pond at Bonython Park (red arrow); B) little corella sites identified by the survey; C) defoliation of a roost tree adjacent to the water resource; D) little corellas drinking water at Bonython Park

Little corella sites were reported throughout the West Parklands around the Adelaide High School ovals and Bonython Park, Adelaide City. Little corellas feed on the grassed areas of these sites, and move to Bonython Park to drink (B, D). Increasing bank height at Bonython would remove this resource and would influence overall site attractiveness. An integrated plan would also include revegetation activities to increase understory areas, removal of Aleppo pines, and communication and community education components.

Target water resources at landscape level

Photo panel 14 *Target little corella water resources associated with problem sites*

A) At University of Adelaide Roseworthy Campus a water treatment pond with black plastic lining excludes little corellas, but other dams with bare banks provide ready access, and stock troughs and Aleppo pines are also abundant at the site; B-C) at Snowtown water resources of town dams are readily available to little corellas (C) and Aleppo pines are abundant (B)

(no)Barriers to river water at problem sites

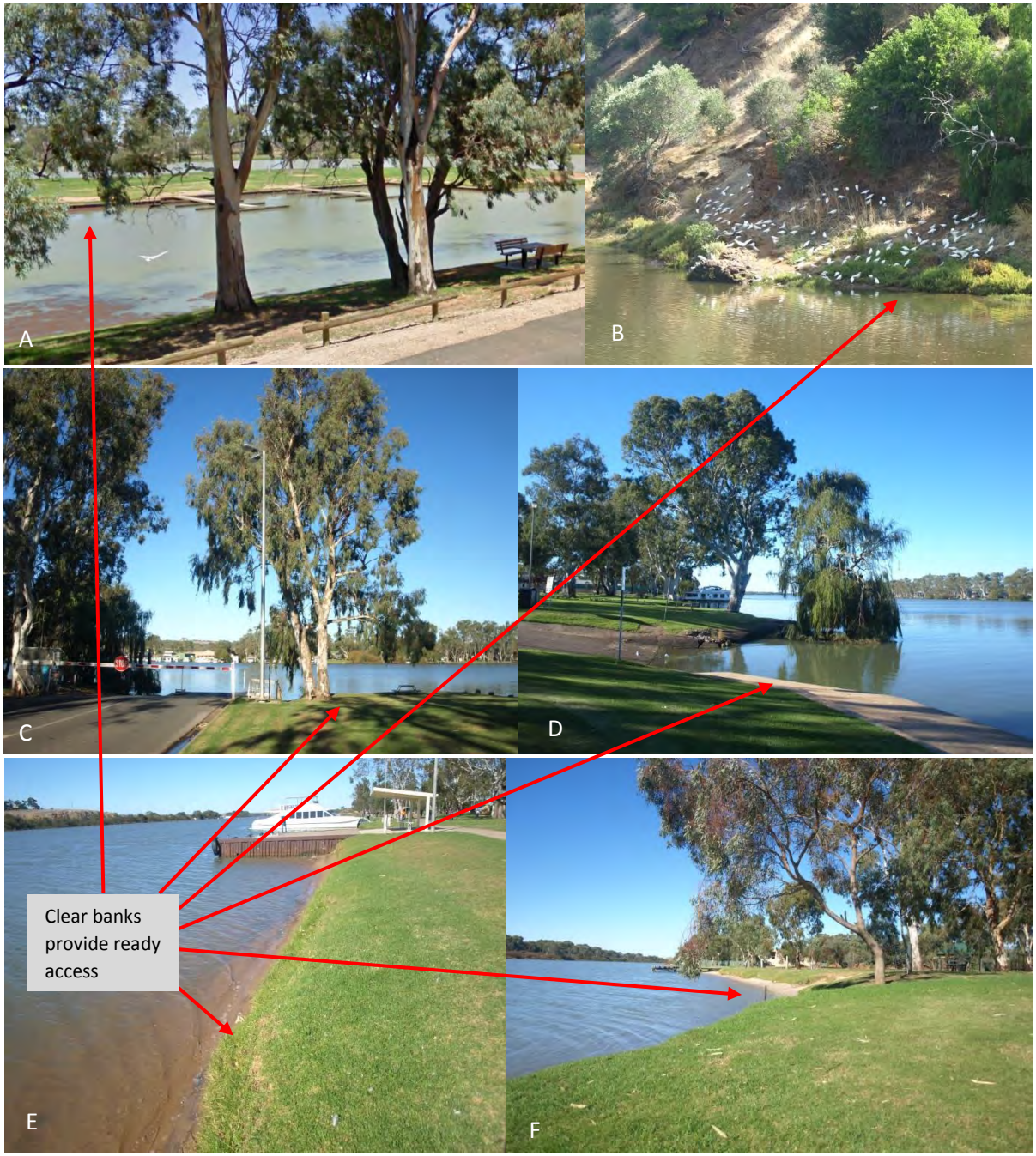


Photo panel 15 *Little corella access to water at river sites*

Open habitat with good vantage (high perceptions of safety for little corellas) and exotic grass banks with no shrubs and adjacent roosting resources at: A) Riverside Drive, adjacent to Berri Riverside Caravan Park; B) Old Noarlunga; C) Mannum Ferry Terminal; D) Many Ann Reserve, Mannum; E) Sturt Reserve, Murray Bridge; F) Long Island Boat Marina, Murray Bridge

3. Identifying and creating sacrificial areas

Sacrificial sites are:

- Identified, suitable areas deliberately set aside for little corella habitat
- Sites where no deterrence or control activities occur
- Sites that little corellas are encouraged to move into and away from problem sites
- Sites that provide suitable feeding, watering, and roosting resources
- Sites that little corellas should eventually become accustomed to and return to habitually

Note that the term "sacrificial" in this context does not imply that the site is of no value, but that the area is set aside for this purpose, to offset damage to and concern about specific sites elsewhere.

A recipe for a sacrificial site

- Is the site near or adjacent to a major creek or other **suitable reliable water** source?
- Does it have **tall scattered gum trees** (trees must not be too dense)?
- Is the **habitat open with good visibility**? (Can little corellas see threats coming from all directions?)
- Is the grass irrigated? If so, does little corella presence conflict with use/users?
- Is the **grass slashed** regularly? (Little corellas feel unsafe in long grass because visibility is reduced)
- Do the **surrounding landholders** want (or tolerate) the little corellas there?
- Are **supplementary** feeding and watering provisions required during roost establishment?
    - Water provision (e.g. a trough) may be sufficient in the long-term
- Are the birds **free of harassment** at this site and on surrounding properties (e.g. from shooting)?
    - Birds should not be harassed when commuting to and from this site

Broader considerations for sacrificial sites

- Previously when little corellas have been displaced from their usual roosting (problematic) site, **where did they go**?
    - Do they always go to the same location?
    - Is this location suitable as a sacrificial site, or is it a "no go" location for the community?

    - Is it better that they stay where they are?
- Local councils may need to experiment with the flock by deliberately displacing them to determine **their behaviour and site preferences**
- Little corellas may in part seek out townships for **reasons of safety**, including:
    - A general absence of predators (e.g. eagles); and/or to
    - Escape hostility in the surrounding landscape (e.g. shooting)
- Councils must cooperate to ensure that they don't play "**aerial ping-pong**" with little corella flocks
- Councils must **monitor and review** their sacrificial site strategies

An important consideration for all sacrificial areas is **what actions are co-occurring at problem sites** to make the sacrificial area effective as a management tool. Isolated management tools won't work. Little corellas need to be discouraged from problematic sites and, simultaneously, encouraged to sacrificial sites.

Little corella management tool – Master model and management scenarios

The little corella management modelling tool has been developed to increase understanding of the complex relationships among factors influencing little corella problem sites. The model is necessarily simplified in order to make it comprehensible. The model (depicted in Figure 15) was developed in ***Mental Modeler*** and is available for download at: http://www.discoverycircle.org.au/projects/little-corellas/community-models/

The model is general and may need to be adapted to local conditions. Table 9 includes descriptions of each of the components in the model. Table 10 provides some working examples of different management scenarios:

- Increasing sacrificial areas ONLY
- Increasing lethal population control ONLY
- Noise deterrents ONLY
- Noise deterrents and lethal deterrents
- Increase understory plantings (shrub layer) ONLY
- Public education ONLY
- Do nothing (i.e. little corella problem sites increase)
- Integrated management

Three integrated management case studies are also provided:

1. Aldinga
2. Hawker township
3. Hewett Primary School

Instructions in the use of ***Mental Modeler*** are available online and are also included as Appendix 6 of this report.

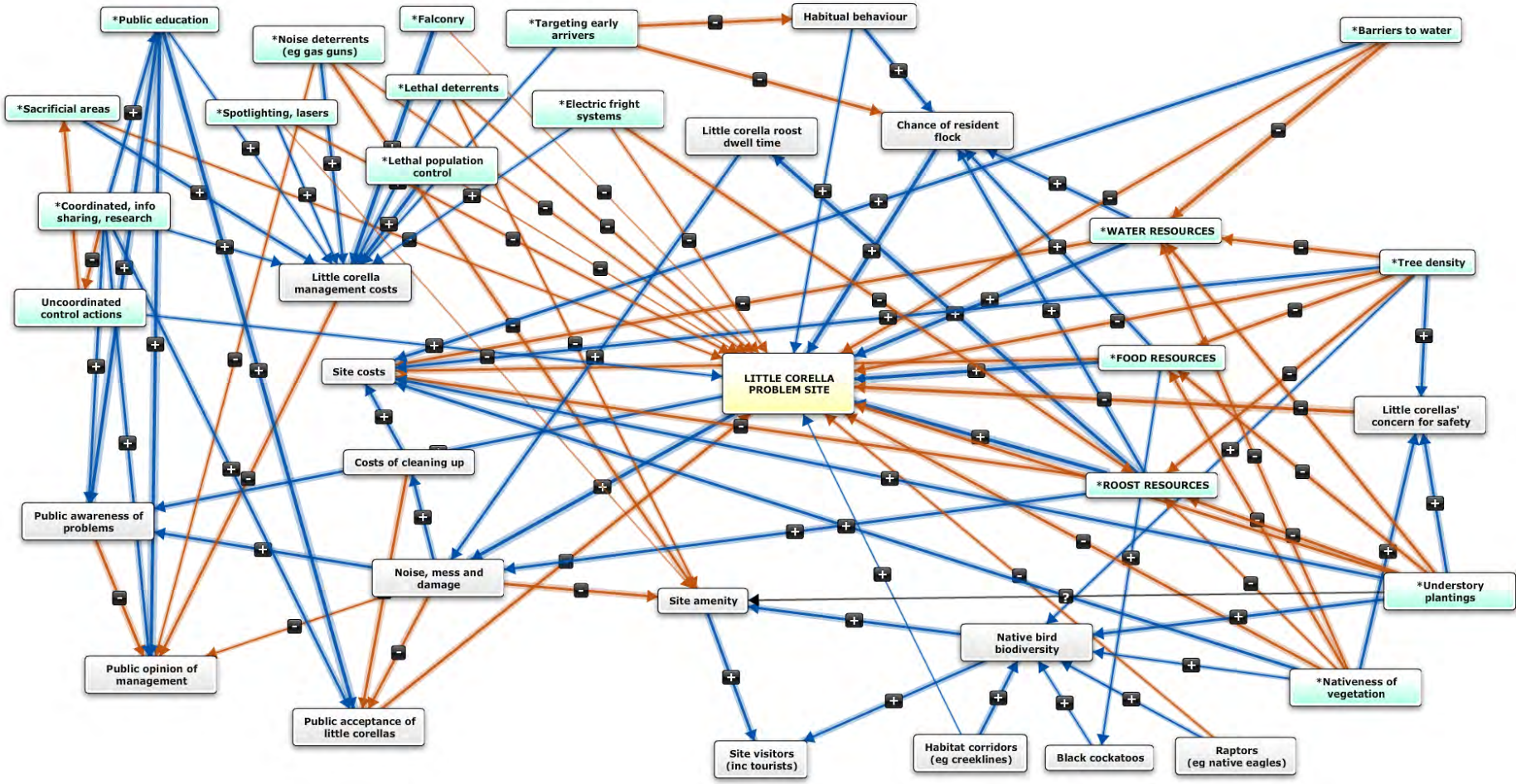


Figure 15 *The master model created during the **Little Corellas** project*

Table 9 *Description and influence of mental model components*

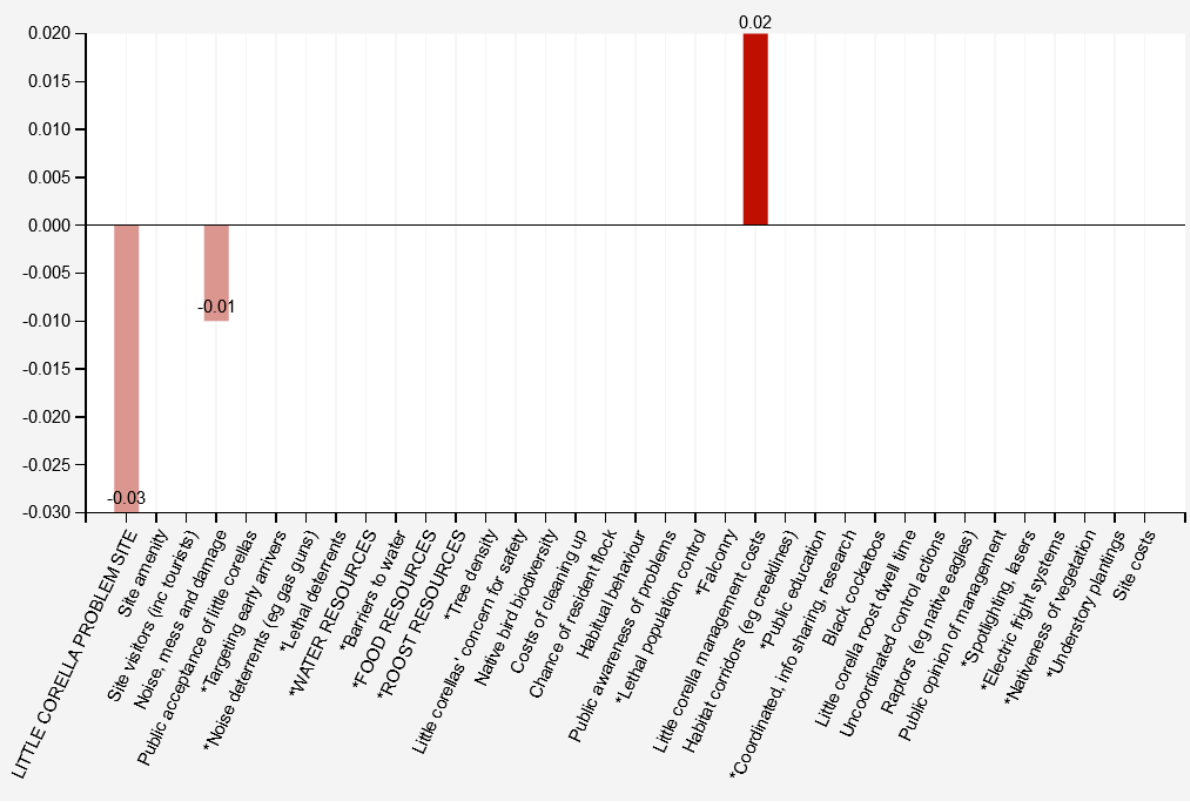
MODEL COMPONENT	COMPONENT DESCRIPTION AND INFLUENCE
LITTLE CORELLA PROBLEM SITE	Identified, specific locations where little corella presence is problematic to some members of the community
Water resources	Typically, *problem sites* and *resident flocks* have water access: rivers, creeks, wetlands (natural and reconstructed), effluent ponds, dams, and stock troughs. Water resources decrease as *nativeness of vegetation*, *tree density* and *understorey plantings* increase (visual barriers decrease little corella perceptions of safety)
Barriers to water	Physical barriers can reduce access to water, including stock trough modifications, dam lining, reeds at water edge, increased bank height, and other screens
Food resources	Typically, *problem sites* have food access including: irrigated grass, agricultural spillage, crops, exotic pines and open ground. Food resources decrease as *nativeness of vegetation*, *tree density* and *understorey plantings* increase
Roost resources	Typically *problem sites* are roosting areas, resources include low density tall trees in open habitat. *Roost resources* decrease as *nativeness of vegetation*, *tree density* and *understorey plantings* increase and *bird fright systems* increase. *Roost resources* also increase *roost dwell time* and *public experience of noise, mess and damage*
MANAGEMENT ACTIONS	
Management costs	All control activities (indicated by asterisk * in the model) incur a cost; cost vary among activities, e.g. *lethal population control* is more expensive than *spotlighting*
Targeting early arrivers	Control activities that *target early arriving* little corellas (ahead of the main flock) will be more effective than actions delayed until the flock resides at the problem site. By *targeting early arrivers*, managers aim to reduce the *chance of resident flock* and alter *habitual behaviour* of flocks from returning to that roost in the future
Habitual behaviour	Little corellas flock to sites habitually; *targeting early arrivers* may deter main flocks from *problem site*. *Resident flocks* increase with habitual use of problem sites
Chance of resident flock	*Resident flocks* are small groups of little corellas that reside year-round at *problem sites* instead of dispersing for several months in the cool periods. These flocks are increasing in some areas, and resident birds increase incidences of *problem sites* when the main flock returns to join them there. Reliable and freely-available *water, food and roost resources* increases the *chance of resident flock*
• ***Noise deterrents*** • ***Lethal deterrents*** • ***Lethal population control*** • ***Spotlighting/lasers*** • ***Electric fright system*** • ***Falconry*** • ***Sacrificial areas***	These control measures are all linked to *management costs* and to reducing *little corella sites*; the weighting of their cost and influence varies among techniques. For example, *falconry* has high management costs and little negative influence on *problem sites*, *lethal deterrents* have a lower relative cost and greater affect in conjunction with other actions (strategic effort) From our survey and workshops we found that *noise deterrents*, *lethal deterrents* and *spotlighting* also had various levels of negative influence on *site amenity*
Uncoordinated control actions	These activities, including non-strategic shooting nearby, undermine coordinated actions and may increase *problem sites*. *Uncoordinated actions* also decrease the effectiveness of *sacrificial sites* as a management tool
Information sharing and research, process formalised	A cohesive approach enhances effectiveness of strategic tools, such as *sacrificial sites*, and decreases problem sites. It also increases *public education*, *public awareness of issues*, *public opinion of management actions*, and *public acceptance of little corellas*
Public education	Education includes *information sharing*; it enhances *public awareness of problems*, *public acceptance of little corellas* and *public opinion of management actions*

MODEL COMPONENT	COMPONENT DESCRIPTION AND INFLUENCE
INCREASING SITE NATIVENESS	
Nativeness of vegetation	Revegetation programs, restoring sites with native plants, decreases *problem sites*
Tree density	Increasing *tree density* tends to reduce *roosting resources* for little corellas, because they like tall sparse trees in open landscapes for good visibility (perception of safety)
Understorey plantings	Revegetation programs, restoring and amending sites to *enhance understory vegetation* (especially shrubs) with local native plants, reduces *problem sites*
Bird biodiversity	The range of bird species present at the problem site; we found no evidence that little corellas decrease *bird biodiversity* at *problem sites* (often sites are in townships with already reduced bird biodiversity). However, increasing *site nativeness* and improving *understory vegetation* will benefit *bird biodiversity* at managed sites
Black cockatoos	These birds enhance overall *bird biodiversity*, and share some *food resources* with little corellas (e.g. pine nuts); therefore, if *food resources* for little corellas are reduced then *black cockatoos* may also be affected (the model will flag this impact and it needs to be considered carefully as some black cockatoos are endangered)
Little corellas' concern for safety	A clear field of view provided by open habitat increases little corella perceptions of safety and their association with a particular site. Increasing the *nativeness of vegetation*, *tree density* and *understory plantings* will decrease site vantage and *problem sites*. *Raptors* also decrease perceptions of safety
Habitat corridors	These areas include creek lines, which provide favourable habitat (*food, water roost resources*) for little corellas and increase *problem sites*
OTHER SITE FACTORS	
Site amenity	Amenity at the *problem site*; *site amenity* will decrease at *problem sites*; noise controls may also decrease amenity, but reducing the problem will enhance amenity
Site visitors	Visitors are linked to *site amenity*, including tourists; site visitation will decrease as little corella site problems increase
Little corella roost dwell time	The time spent by little corellas in tree roosts at problem sites; *roost resources* will increase *dwell time* and the more time that little corellas spend there the more opportunity for the *public to experience noise, mess and damage* to trees by the birds
PUBLIC EXPERIENCE AND OPINION OF LITTLE CORELLAS	
Public experience of noise, mess and damage	Includes experience of damage to trees and infrastructure, and droppings and tree debris (mess). This component increases with increases in *problem sites*, and decreases with their reduction
Costs of cleaning up after little corellas	These costs increase with *problem sites*, as *public experience of mess, noise and damage* increases
Public acceptance of little corellas	As *problem sites* decrease, *public acceptance* of little corellas increases. *Public acceptance* also decreases as experience of impacts and associated costs increases
Public opinion of management actions	Public opinion decreases with increases in *problem sites*, and *opinion of actions* increase as *problem sites* decline (i.e. the public want effective actions)
Public awareness of problems	*Problem sites* and their impacts will increase *public awareness* of management issues, so does *information sharing* and *public education*

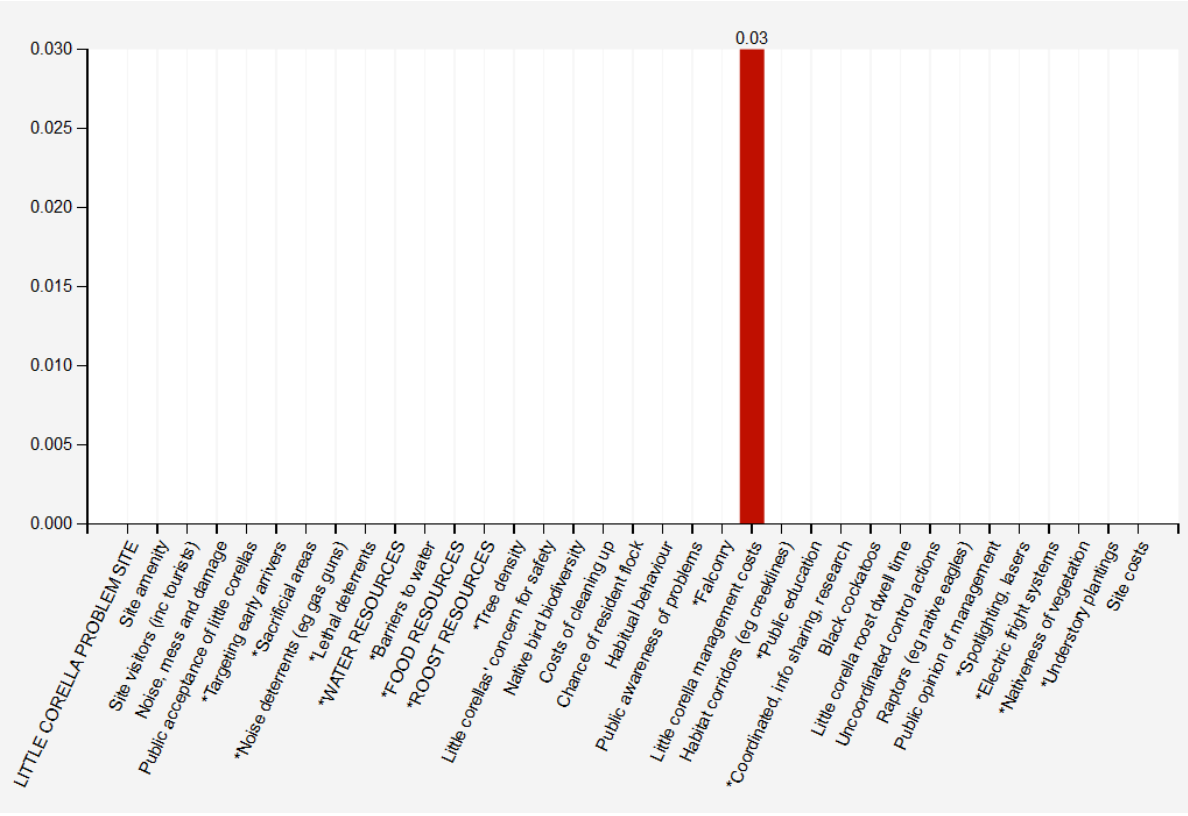
Table 10 *Outcomes of simple and integrated little corella management scenarios*

The Mental Model enables managers to see where trade-offs and benefits occur for different scenarios; Table 8 shows components that increased and decreased, and the level of effect

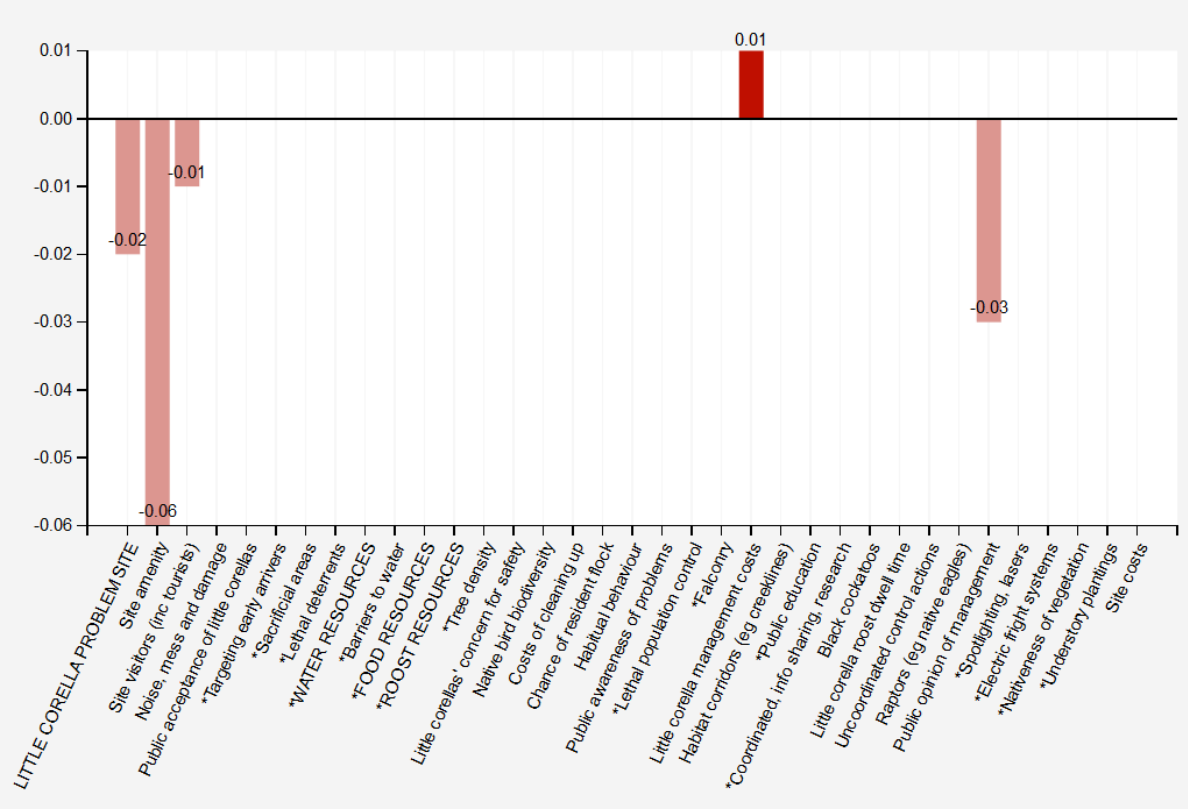
MANAGEMENT SCENARIO	INCREASES	DECREASES	OVERALL EFFECTIVENESS
Increasing sacrificial areas ONLY	Management costs (0.02)	• Little corella problem site (-0.03) • Noise, mess and damage (-0.01)	**POOR:** very little effect on decreasing little corella problem sites, and management costs accrued- **sacrificial areas only work with measures taken at problem sites to discourage little corellas**



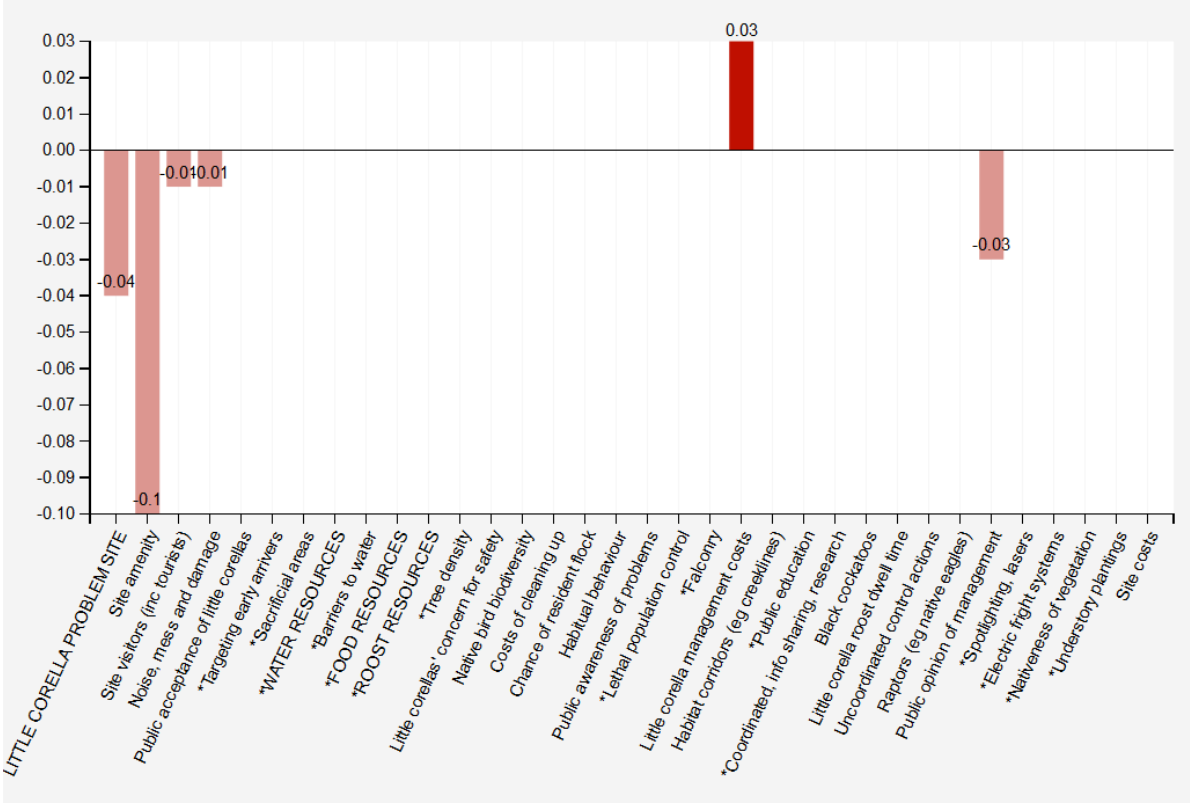
MANAGEMENT SCENARIO	INCREASES	DECREASES	OVERALL EFFECTIVENESS
Increasing lethal population control ONLY	Management costs **(**0.03**)**	NONE	**VERY POOR**: NO effect on decreasing little corella problem sites in the longer term as populations will recover and return; management costs accrued



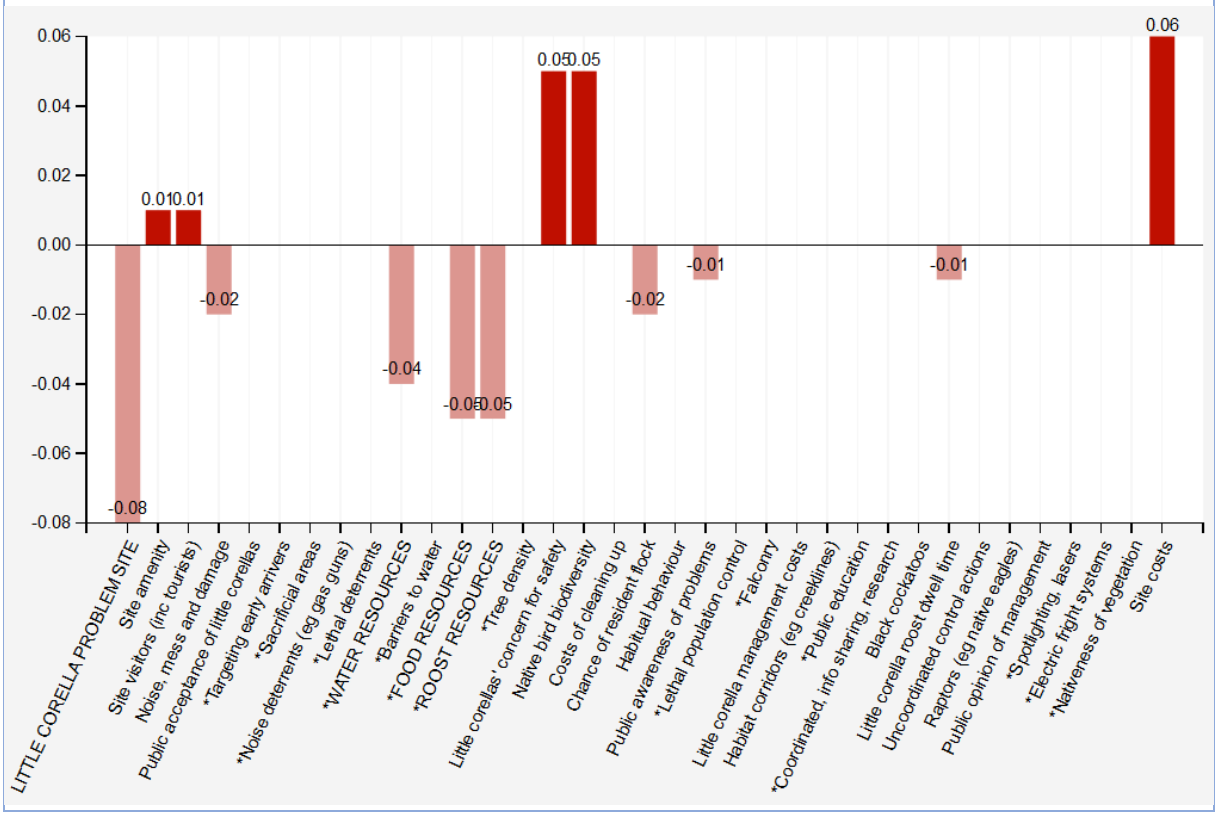
MANAGEMENT SCENARIO	INCREASES	DECREASES	OVERALL EFFECTIVENESS
Noise deterrents ONLY	Management costs (0.01)	• Little corella problem site (-0.02) • Site amenity (-0.06) • Public opinion of management actions (-0.03) • Site visitors (-0.01)	**POOR**: very little effect on deceasing little corella problem sites, site amenity is negatively affected, and management costs accrued However, noise deterrents may be effective as part of an integrated strategy



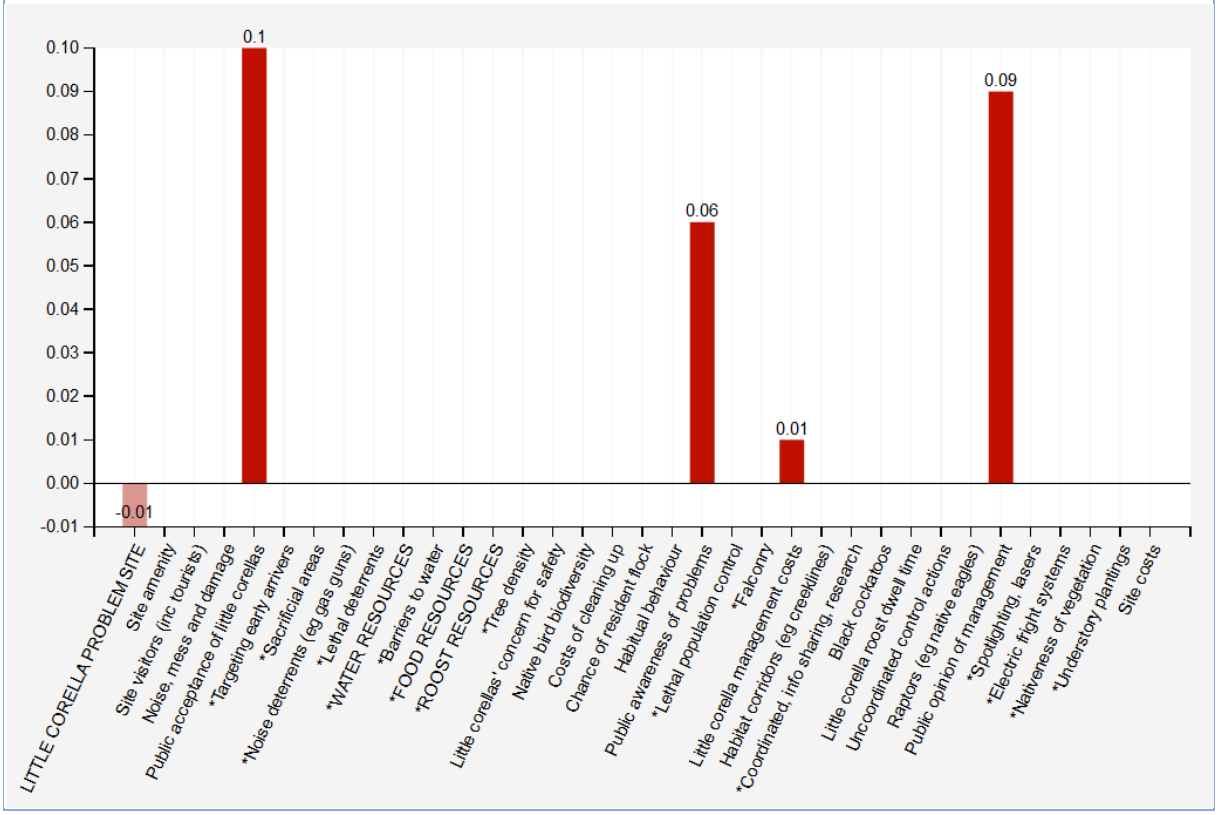
Management scenario	Increases	Decreases	Overall effectiveness
Noise deterrents AND lethal deterrents	Management costs (0.03)	• Little corella problem site (-0.04) • Site amenity (-0.10) • Public opinion of management (-0.03) • Site visitors (-0.01) • Noise, mess and damage (-0.01)	**POOR-MODERATE**: using noise and lethal deterrents together enhances the effect of the control measures and decreases problem sites. Some perceived loss of amenity also occurs



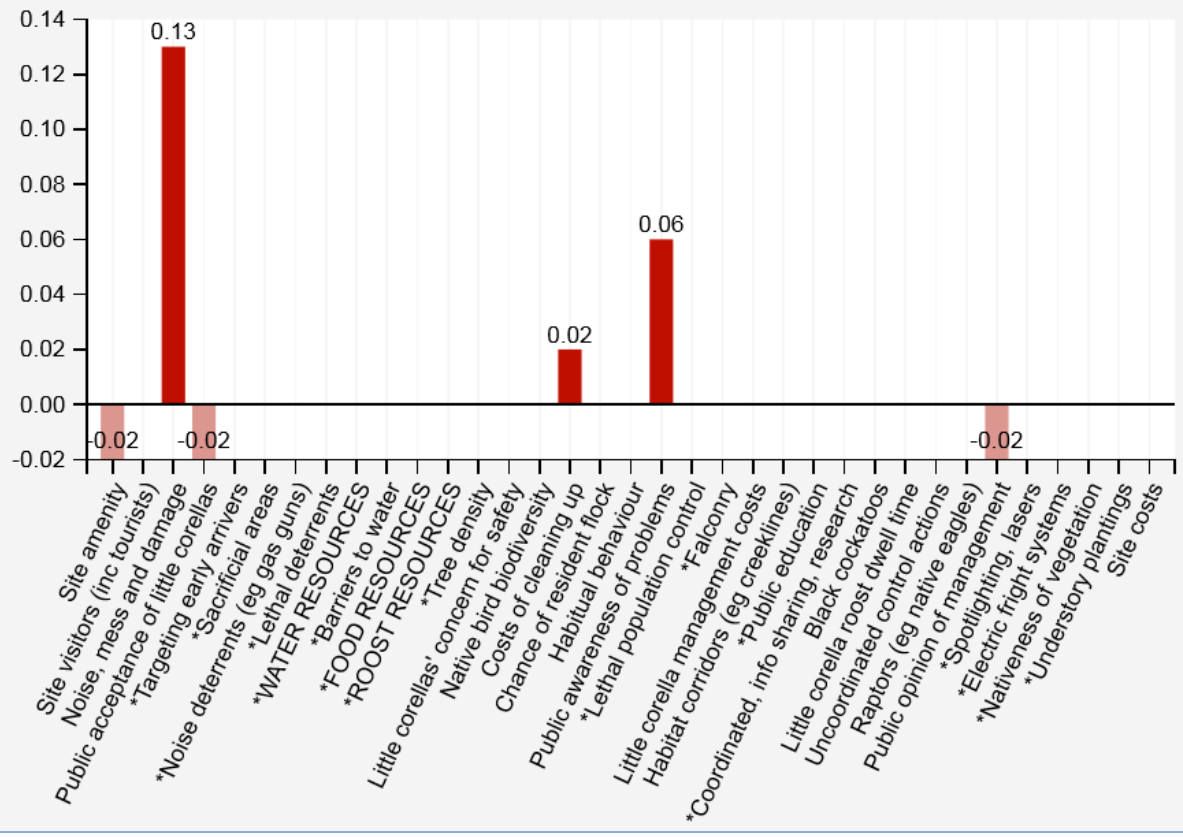
MANAGEMENT SCENARIO	INCREASES	DECREASES	OVERALL EFFECTIVENESS
Increase understory plantings (shrub layer) ONLY	• Site management costs (0.06) • Bird biodiversity (0.05) • Little corellas' concern for safety (0.05) • Site visitors (0.01) • Site amenity (0.01)	• Little corella problem site (-0.08) • Food resources (-0.05) • Roost resources (-0.05) • Water resources (-0.04) • Chance of resident flock (-0.02) • Public experience of noise, mess and damage (-0.02) • Public awareness of problems (-0.01) • Little corella roost dwell time (-0.01)	**MODERATE**: small effect on decreasing little corella problem sites, broad positive influence otherwise, for comparable management costs to other isolated actions (sacrificial site, lethal population control or noise deterrents ONLY)



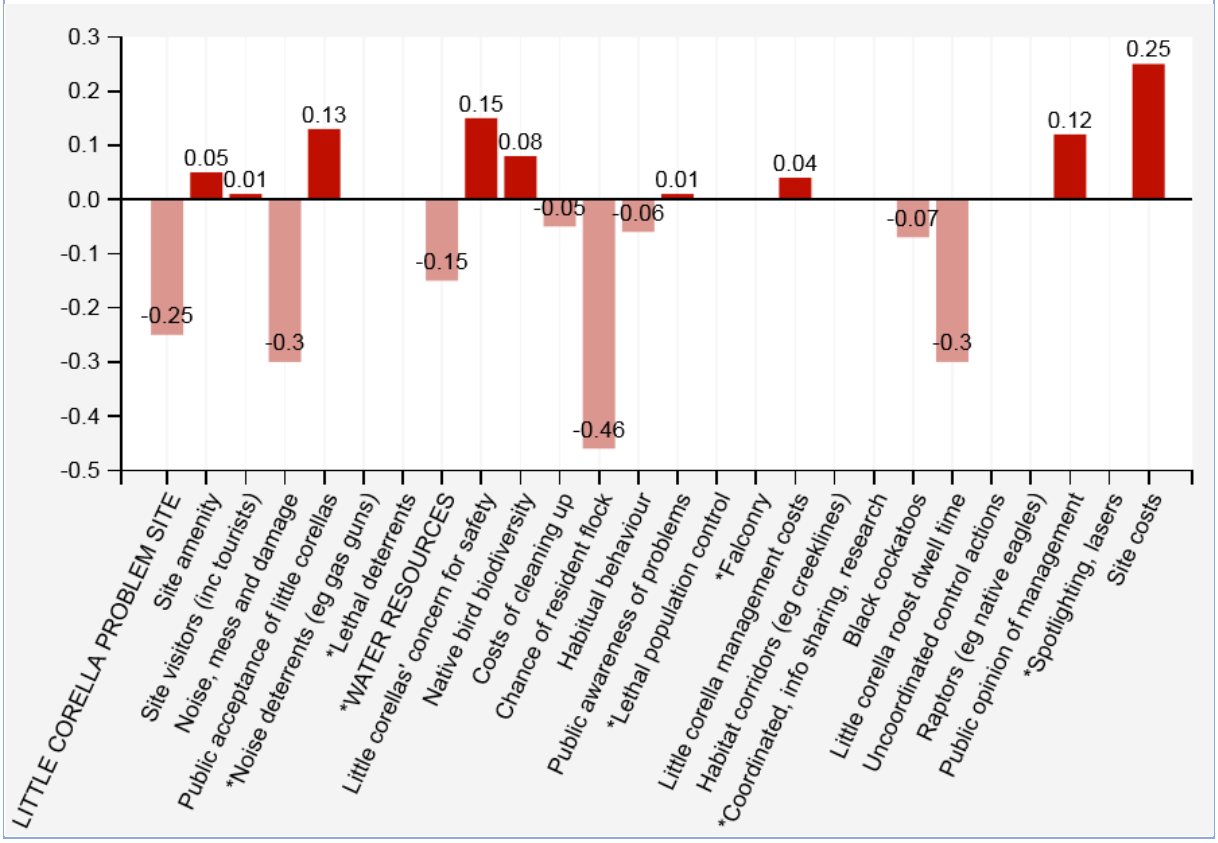
MANAGEMENT SCENARIO	INCREASES	DECREASES	OVERALL EFFECTIVENESS
Public education ONLY	• Public acceptance of little corellas (0.10) • Public opinion of management (0.09) • Public awareness of problem (0.06) • Management costs (0.01)	• Little corella problem site (-0.01)	**POOR-MODERATE**: little effect on decreasing little corella problem sites; however for comparable costs to other single-action strategies, considerable public engagement (acceptance, awareness, opinion of actions) is achieved



MANAGEMENT SCENARIO	INCREASES	DECREASES	OVERALL EFFECTIVENESS
Do nothing (i.e. little corella problem sites increase)	Noise, mess and damage (0.13) Public awareness of problems (0.06) Costs of cleaning up (0.02)	• Site amenity (-0.02) • Public acceptance of little corellas (-0.02) • Public opinion of management (-0.02)	**VERY POOR**: no action will increase public experience of impacts, awareness of problems and costs of cleaning up; social costs include the loss of amenity, reduced acceptance of little corellas and low opinion of management actions



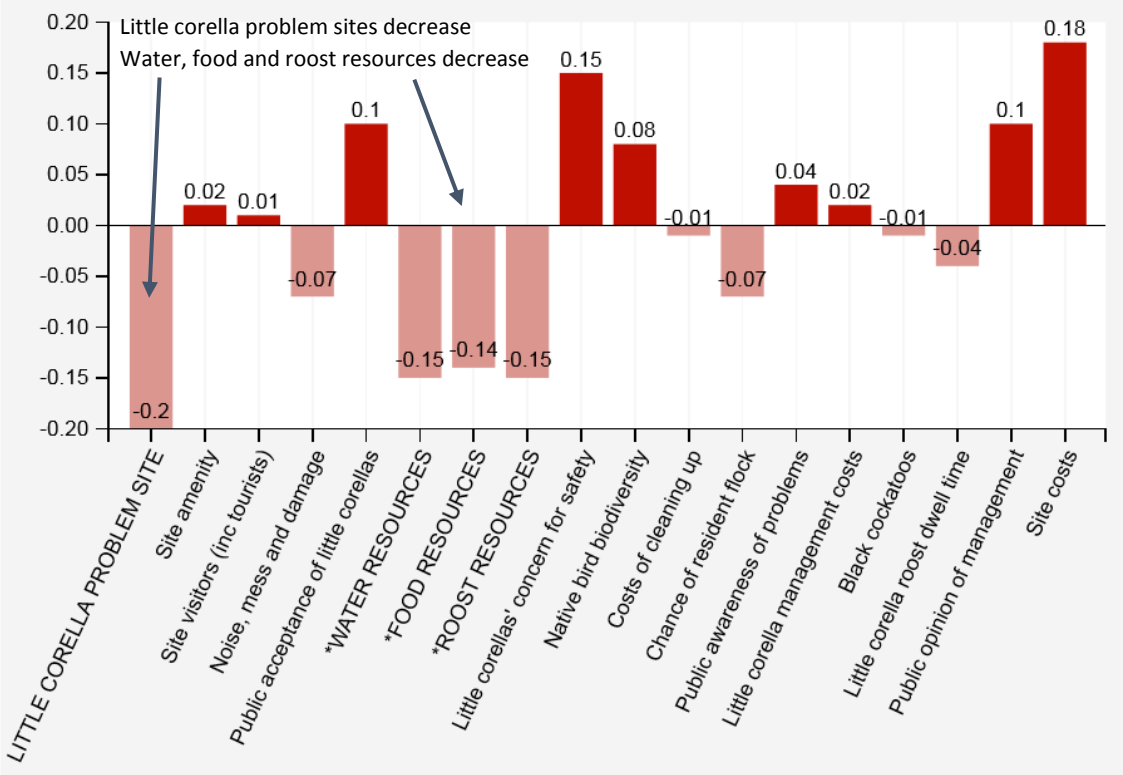
MANAGEMENT SCENARIO	INCREASES	DECREASES	OVERALL EFFECTIVENESS
Integrated management • Targeting early arrivers • Sacrificial areas • Barriers to water, food and roost resources • Increase tree density, nativeness of vegetation and understorey plantings • Electric fright system • Information sharing	• Site costs (0.25) • Little corellas' concern for safety (0.15) • Public acceptance of little corellas (0.13) • Public opinion of management (0.12) • Native bird biodiversity (0.08) • Site amenity (0.05) • Management costs (0.04) • Site visitors (0.01) • Public awareness of problem site (0.01)	• Chance of resident flock (-0.46) • Public experience of noise, mess and damage (-0.30) • Little corella roost dwell time (-0.30) • Little corella problem site (-0.25) • Water resources (-0.15) • Black cockatoos (-0.07) • Habitual behaviour (flocks returning to problem sites) (-0.06) • Costs of cleaning up after little corellas (-0.05)	**VERY HIGH**: very strong effect on reducing little corella problem sites, broad positive influence, very strong influence on reducing chance of resident flock (and creation of more problem sites)



Case study 1: Aldinga

Recommended actions:

- Revegetate open roadside areas to increase shrub cover (and visual screening) and reduce foraging opportunities and perceptions of safety for little corellas
    a. Dense plantings of low-statured trees is also effective and low maintenance
    b. Use temporary material/synthetic screens to deter birds from revegetated areas
- Remove declared weeds, especially Aleppo pines, replace with local plant varieties
- Create a visual and/or physical barrier to water through planting reeds around dam edges, installing a dam liner, and increasing density and cover of native plants in adjacent areas
- Install barriers to stock troughs in the area
- Consider the social impact of removing significant trees, even declared weeds. Old trees need to be replaced eventually and local native species should replace them. More shrub and screening vegetation should occur around the oval to make it less attractive to little corellas overall
- Install a non-lethal electric bird fright system to deter little corellas from roosting in severely defoliated trees; move the system to affected (problematic roosting) areas as required
- Provide information materials for the public, consult and engage all stakeholders
- Monitor and review



Model actions were:

- *Increase barriers to water*
- *Increase tree density*
- *Increase public education*
- *Increase understorey and nativeness of vegetation*
- *Increase electric fright systems*

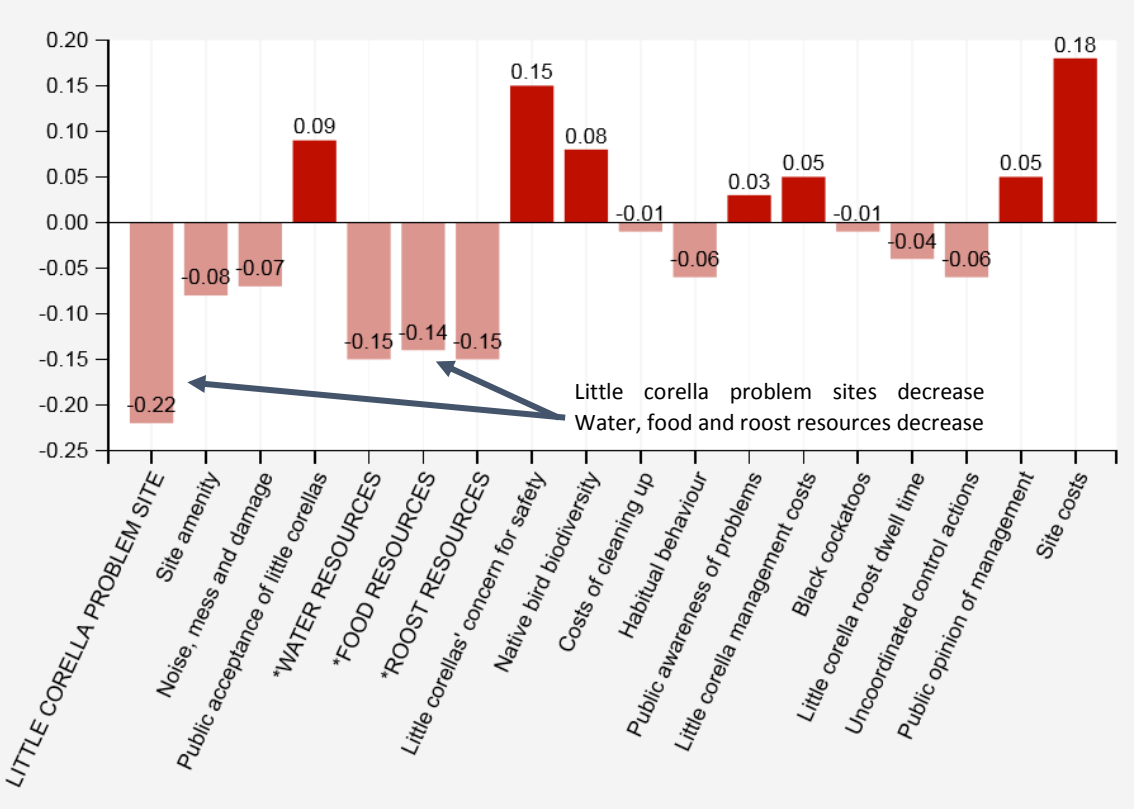
Management outcomes

- Large decreases occur for: little corella problem sites; access to water, food and roost resources; chance of resident flock
- Noise, mess and damage (and costs of cleaning up) and roost dwell time also decreased
- Large increases occurred for site costs, little corellas' concern for safety, public opinion of management and native bird biodiversity
- Public awareness of problem increased (with public education); management costs and site amenity and site visitors increased slightly
- Black cockatoos decreased slightly because of reduced access to Aleppo pine resources, this management action should be considered closely and planned with advice from NRM and bird groups

Case study 2: Hawker Township

Recommended actions:

- Town dam (circled in red):
    a) Install temporary hessian/canvas/shade cloth screens to fill in the gaps in existing vegetation and create a visual barrier to the water
    b) Revegetate the gaps (over time) to create a long-term closed visual barrier to water
    c) Install a dam liner to help conserve water
    d) Consider removal of the tree at the dam site, (risk: high public opposition exists for tree removal generally), or
    e) Install a non-lethal electric fright system (e.g. BirdJolt) within the tree to deter the birds from using it as safe retreat
        - Move the system around to other problematic areas in Hawker
- Modify stock troughs near the town to exclude little corellas; review and amend access to all water resources near other problem sites (hospital, golf course, and racecourse), including secondary dams (circled in orange)
- Increase understory vegetation and tree density at other problem sites (e.g. golf course)
- Install temporary signage to let local people know what is being done, and why
- Monitor and review



Management actions were:

- Target early arrivers
- Establish sacrificial areas
- Noise and lethal deterrents
- Establish barriers to water resources
- Increase tree density, vegetation understorey and nativeness
- Coordinate response, share information
- Electric fright system

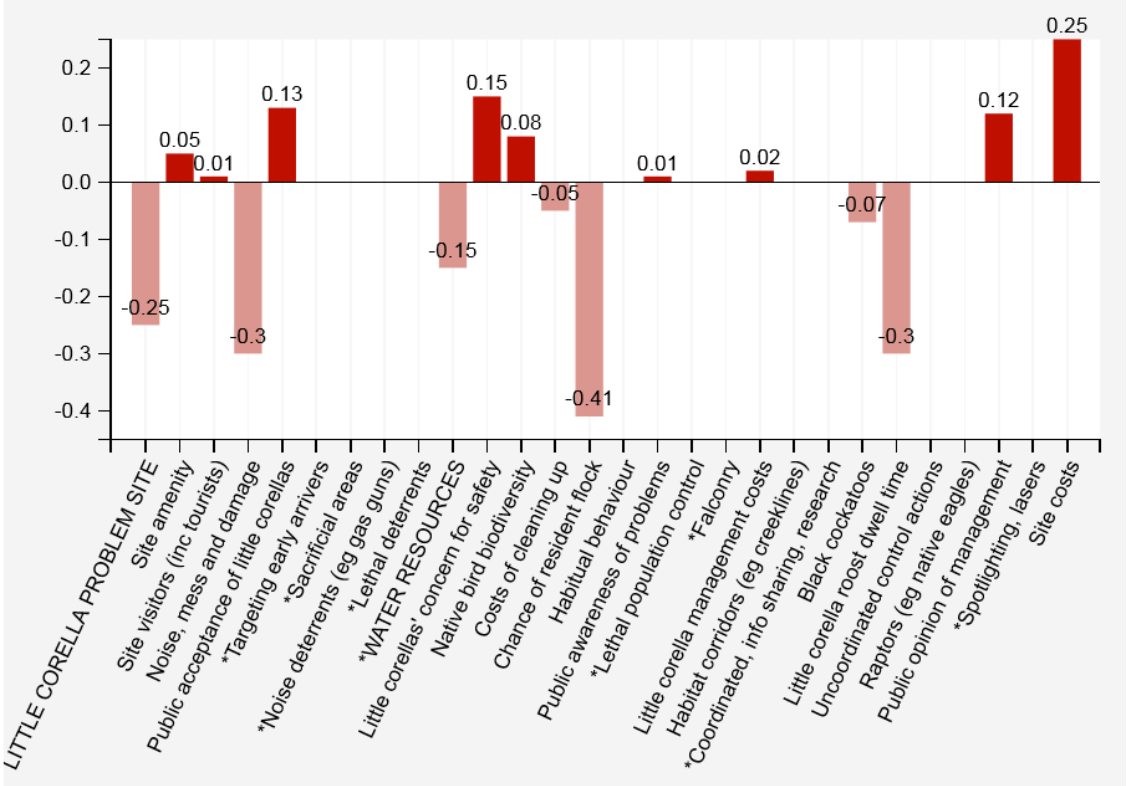
Management outcomes

- Large decreases occur for: little corella problem sites; water, food and roost resources; site amenity; noise, mess and damage
- Uncoordinated control actions, habitual behaviour, roost dwell time and costs of cleaning up also decreased
- Large increases occurred for: site costs; little corellas' concern for safety; public acceptance of little corellas; native bird biodiversity; management costs; public opinion of management
- Black cockatoos decrease slightly; whenever this outcome is flagged management should consider closely the activities and plan them with advice from NRM and bird groups. However, black cockatoos do not occur in this area so this flag is not locally relevant and action can proceed

Case study 3: Hewett Primary School

Recommended actions:

- Revegetate around water resources to create a visual and physical barrier
- Revegetate understorey and increase tree density throughout the area (excluding oval)
- Revegetate bare ground areas around the school to remove foraging opportunities
- Use sturdy tree guards and/or temporary material screens at revegetation sites to deter birds from the area while the plants establish
- Install a non-lethal electric fright system on affected buildings, fences or trees to remove roosting resources; move system around to different areas as required
- Install temporary signage at the site to let local people know what is being done, and why
- Monitor and review



Management actions were:

- Establish barriers to water, reduce food and roost resources
- Increase tree density, vegetation understorey and nativeness (remove bare ground)
- Public education
- Electric fright system

Management outcomes

- Large decreases occur for: little corella problem site; chance of resident flock; noise, mess and damage; roost dwell time; water resources; costs of cleaning up
- Large increases occur for: site costs; little corellas' concern for safety; public acceptance of little corellas; public opinion of management; native bird biodiversity; site amenity
- Management costs, public awareness of problem and site visitors also increased
- Black cockatoos decreased slightly; this management action should be considered closely and planned with advice from NRM and bird groups

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Appendix 1: Local council areas or authorities represented by participants in the Little Corella Survey

Local Council Area or Authority	Number of respondents	Local Council Area or Authority	Number of respondents
Adelaide City Council	13	District Council of Mount Barker	26
Adelaide Hills Council	30	District Council of Mt Remarkable	12
Alexandrina Council	76	District Council of Orroroo Carrieton	1
Berri Barmera Council	5	District Council of Renmark Paringa	2
Campbelltown City Council	10	District Council of Streaky Bay	1
City of Charles Sturt	31	District Council of Tumby Bay	1
City of Holdfast Bay	5	District Council of Yankalilla	6
City of Marion	17	Kangaroo Island Council	6
City of Mitcham	21	Kingston District Council	1
City of Mt Gambier	4	Light Regional Council	17
City of Onkaparinga	137	Mid Murray Council	63
City of Playford	20	Municipal Council of Roxby Downs	2
City of Port Adelaide Enfield	30	Naracoorte Lucindale Council	3
City of Port Lincoln	2	Northern Areas Council	3
City of Prospect	5	Outback Communities Authority	1
City of Salisbury	22	Port Augusta City Council	7
City of Tea Tree Gully	30	Port Pirie Regional Council	4
City of Unley	11	Regional Council of Goyder	1
City of Victor Harbor	12	Tatiara District Council	8
City of West Torrens	22	The Barossa Council	26
Clare and Gilbert Valleys Council	4	The City of Burnside	15
Corporation of the Town of Walkerville	3	The City of Norwood, Payneham & St Peters	11
District Council Ceduna	2	The Coorong District Council	2
District Council of Barunga West	2	The Corporation of the City of Whyalla	2
District Council of Cleve	1	The Flinders Ranges Council	12
District Council of Coober Pedy	1	The Rural City of Murray Bridge	21
District Council of Grant	7	Town of Gawler	37
District Council of Karoonda East Murray	1	Wakefield Regional Council	1
District Council of Kimba	1	Wattle Range Council	4
District Council of Loxton Waikerie	11	Yorke Peninsula Council	2
District Council of Mallala	9	**Total**	**843**

Appendix 2: Relationships between measures and demographic variables and two underlying factors (Concern for impact and Intrinsic-value).

Relationships were tested with non-parametric correlations (Spearman's rho, ρ). Statistically significant, meaningful results are highlight with coloured cells, with green cells indicating a positive relationship and red cells indicating a negative relationship

Measurement		Concern for impact factor (ρ)	Intrinsic-value factor (ρ)	Explanation/interpretation
General opinion of little corellas		-0.722*	0.104*	Strong negative relationship between general opinion of little corellas and concern for impact factor scores (typically, **opinion of little corellas decreased as impacts increased**) Positive but weak relationship between general opinions of little corellas and their intrinsic-value score
Opinion of little corellas at primary site		-0.759*	-0.114*	Strong negative relationship between general opinion at primary site and concern for impact factor score (typically, **opinion decreased as impacts increased**) Negative, but weak relationship between opinion of little corellas at a primary site and intrinsic value
Distance of little corella site to home		-0.135*	0.067*	Weak relationships, but directions of relationships are intuitive: as distance from little corella sites increases, concern for impacts decrease (slightly) and the intrinsic factor increases (slightly)
Largest no. of little corellas seen at a site		0.254*	0.041	Weak correlation between numbers of little corellas and concern for impact factor, in intuitive direction: impacts increase as little corellas numbers increase No significant relationship between numbers of little corellas and intrinsic-value factor
How often you notice little corellas in summer (frequency)		-0.138*	0.038	Weak and no relationship
*In the **LAST 5 YEARS**, what has happened to little corellas in your area?*		0.529*	0.010	**Typically, people who feel populations have increased score higher on the concern for impact factor** No significant relationship on the intrinsic-value factor
*In the **NEXT 5 YEARS**, what would you like to see happen to little corellas in your area?*		-0.693*	-0.001	**Typically, people who score high on the concern for impact factor want populations to decrease** No significant relationship on the intrinsic-value factor
Demographics	*Age*	0.093*	-0.055	Weak positive correlation. No significant relationship
	Education level	-0.012	0.047	No significant relationships
	Relationship with natural environment	0.194*	0.115*	Weak positive relationships: the directions and strengths of these relationships are interesting… **It's not just people concerned for the natural environment that love corellas and are <u>not</u> concerned about the impacts of little corellas… while these people might typically be a slightly higher on the intrinsic-value factor, they are also slightly higher on the concern for impact-factor**
	Gender (Mann-Whitney U)	Male: 479* / Female: 372	Male: 421 / Female: 404	**Males typically scored significantly greater concern for impact factor scores than did females** There was not a significant difference between males and females on the intrinsic-value factor

Appendix 3: Participant comments and responses made during the community workshops supporting the value or approach of the workshops, the complexity of the issue, changing opinions and other observations

Themes	Participant comments and responses
About the workshop	• that was "***a really valuable workshop***" • One participant said that the **modelling program was excellent**, and that they could see lots of applications for the program in community engagement activities • At the end of one workshop we asked whether there was anything else that participants would like to cover regarding little corellas, one participant said: "***you've covered it pretty well***"
Participation in the workshop	• In several workshops some people indicated initially that they would not be participating. Yet many of these people **couldn't help participating** and contributing when the discussion turned to their areas of interest or experience • One participant said that he wasn't going to come to the workshop because **he felt frustrated** with the history of little corella management. He felt that management too often consisted of **releasing documents** and he **wanted to see actions** being implemented. However, he was glad that he had attended the workshop, he could understand the process and why it was important, and he hoped to see some action soon. He was happy to see that something was happening
About little corella management	• "*you can **see how complex it is***" • "*people think **too simplistically** about the issue; they're looking for **silver bullets***" • We found some **appetite for long-term approaches** to little corella management: … a "*long-term project is needed*"; "*Public education on the impacts of corellas and other over-abundant species, including kangaroos and koalas is important. I am in favour of addressing the causes of overabundance and management actions to reduce numbers*" • People felt that the **numbers were increasing** • People said that they **didn't know what the council was doing**; they wanted to know what other councils were doing; others felt that council actions were focused on council assets only • Some participants felt that "***poor farm hygiene***" (i.e. spilled grain) contributed to problems with little corellas; few farmers participated in the workshops and it was suggested that little corellas were preferred to rabbits or mice for cleaning up the grain
Attitudes and changing opinions	• "*there were **things I hadn't considered***" • Some people were surprised to find that they **didn't know or understand** what other people in their community were thinking about the issue; some people were **surprised to see how frustrated** others were about little corella management • One participant said that they liked little corellas, but could now understand how they would **not want them in their tree** • Another participant said that they could **now see both sides of the issue**

Appendix 4: Supporting information for state-wide and Mounty Lofty Ranges suitable habitat models

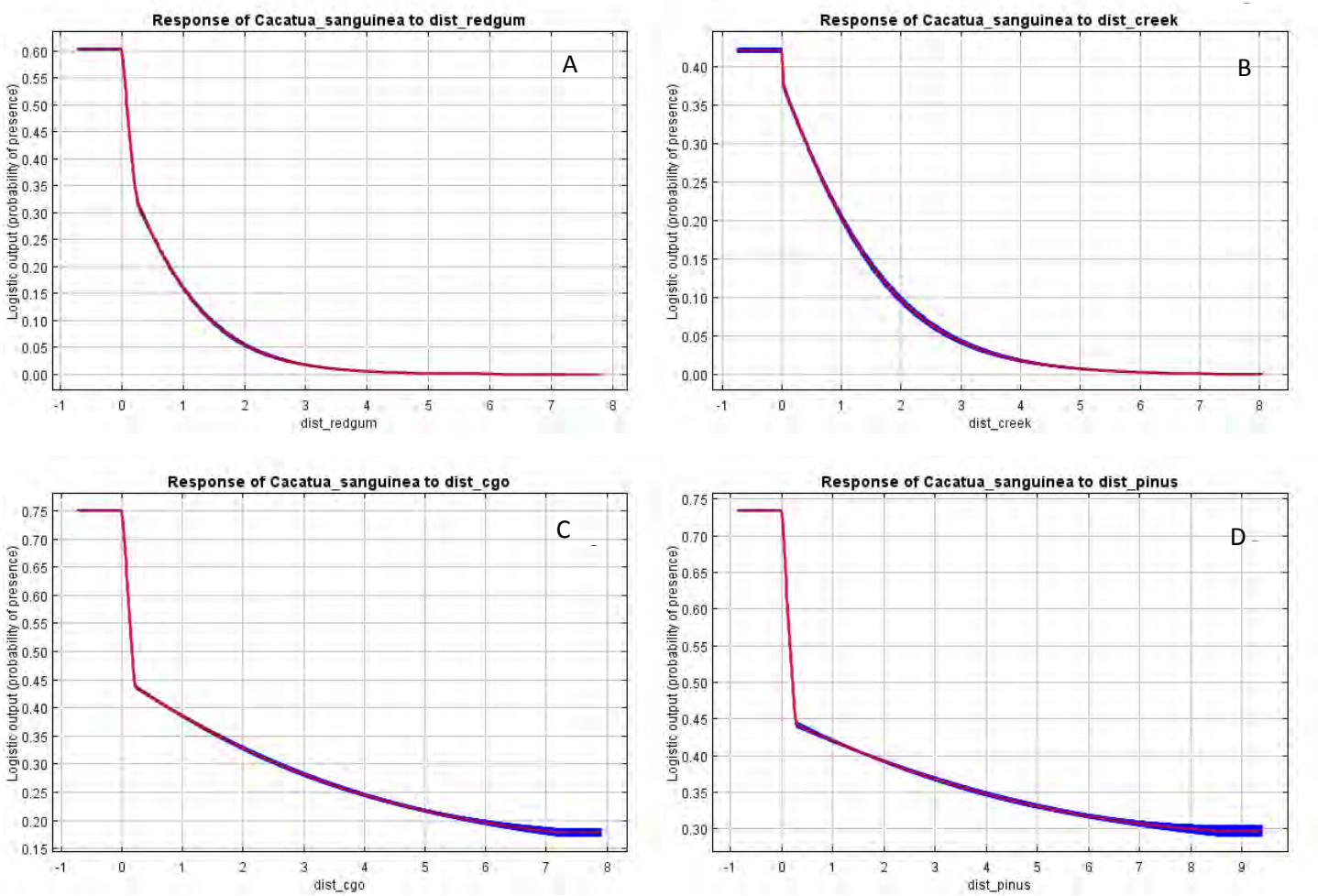


Figure 4.1 *State-wide model: the response of little corellas to distance (m) to nearest: A) river red gum; B) major creek; C) irrigated green space; and D) pine tree. The blue shading indicates variability*

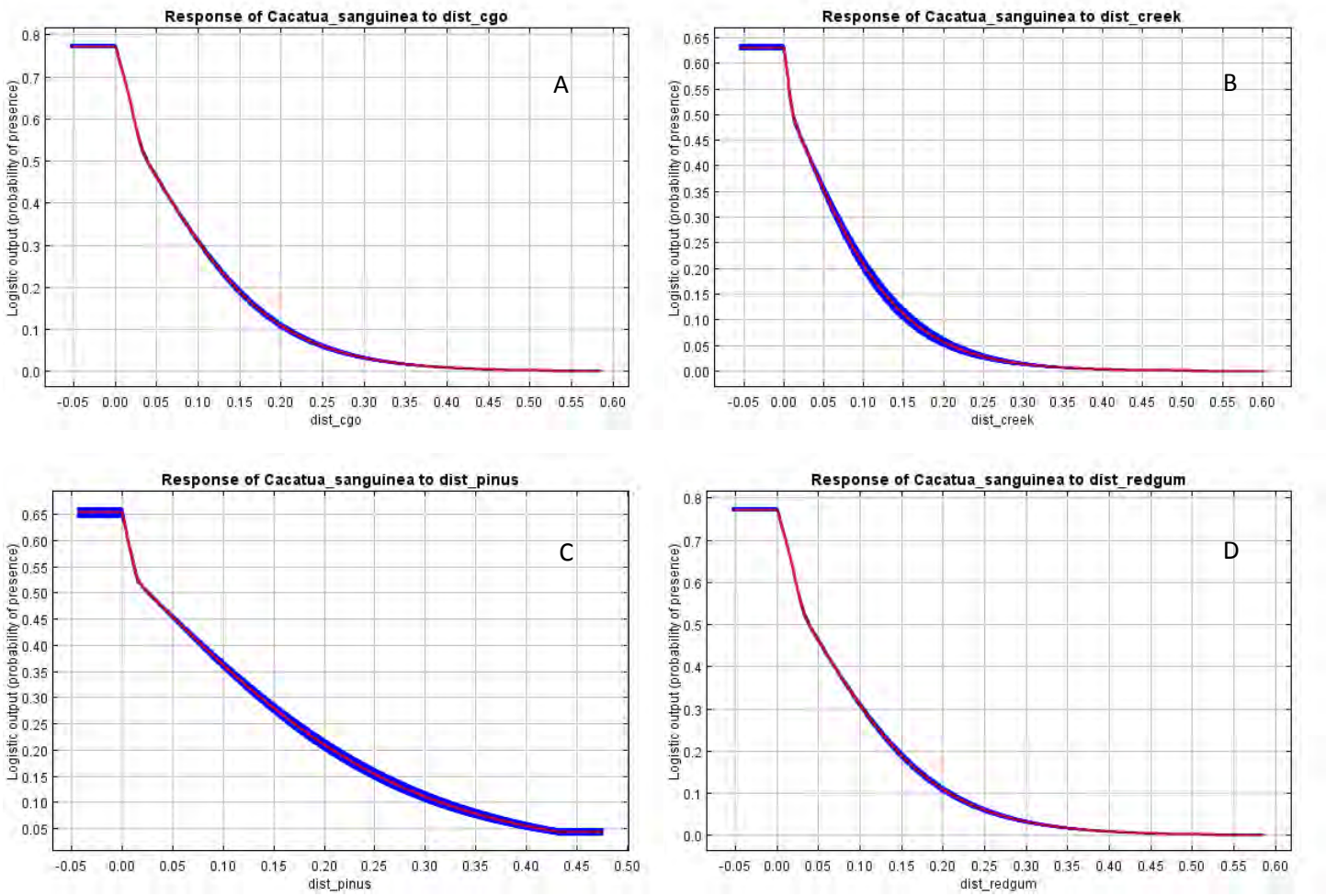


Figure 4.2 *The response of little corellas to distance (m) to nearest: A) irrigated green space; B) major creek; C) pine tree; and D) red gum. The blue shading indicates variability*

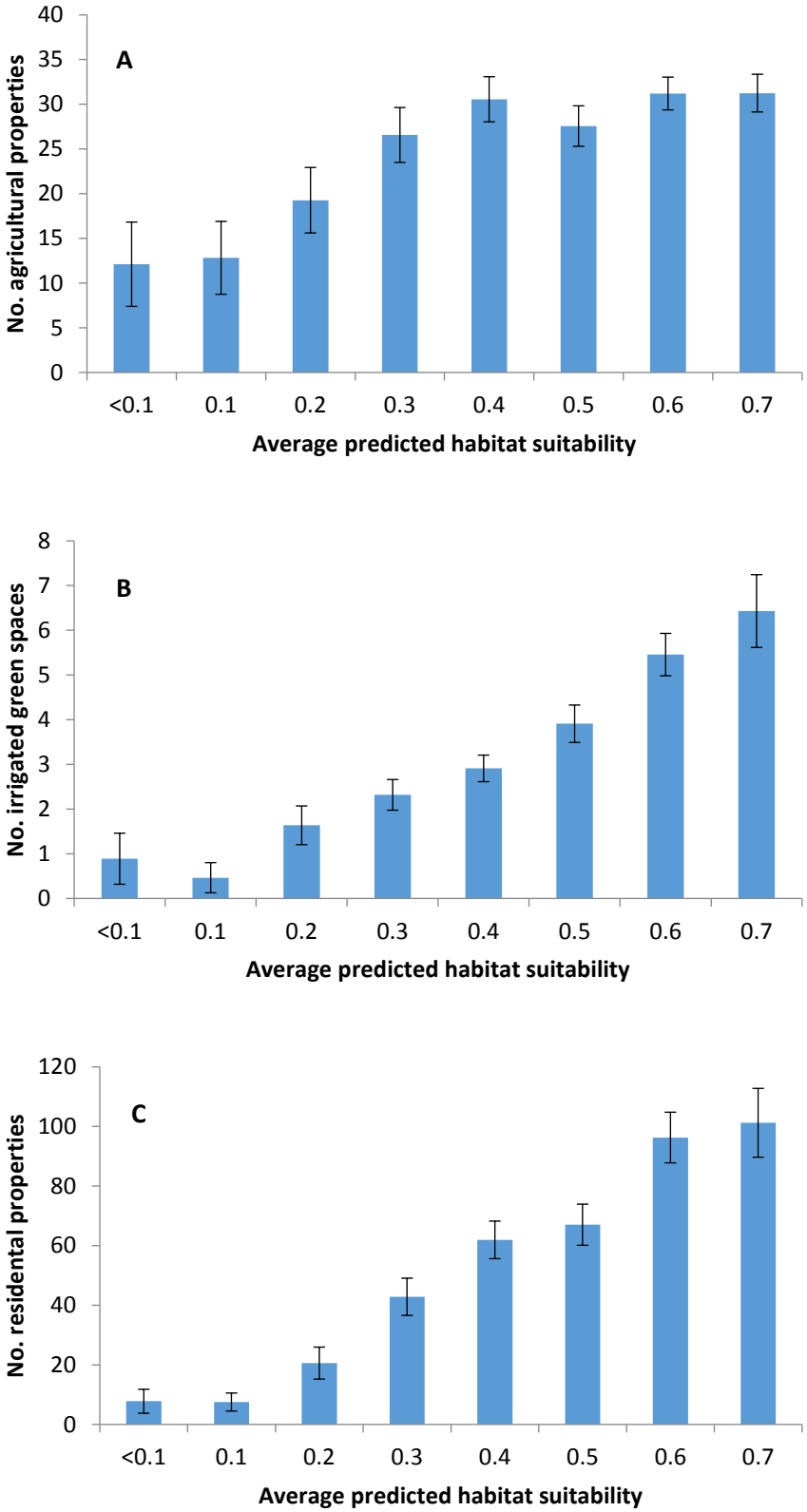


Figure 4.3 *Average predicted habitat suitability for little corellas relative to number of: A) agricultural properties; B) irrigated green spaces; and C) residential properties within a 1 km radius of any given location*

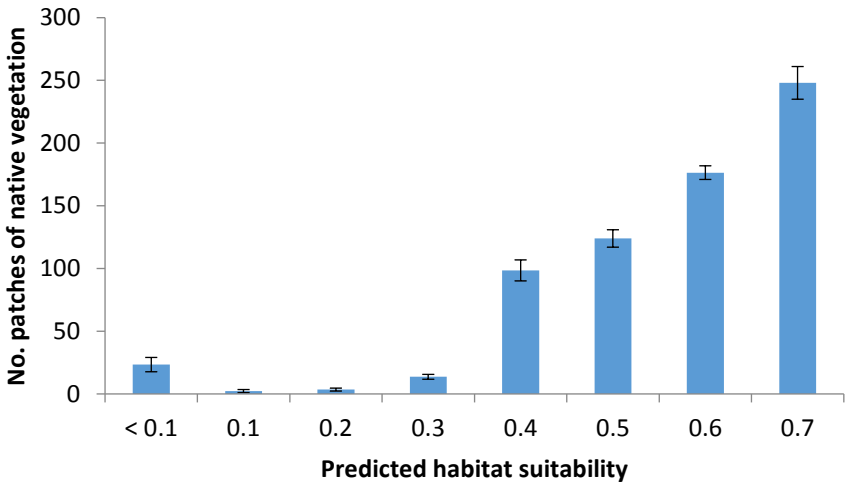


Figure 4.4 *Average predicted habitat suitability for little corellas at any given site versus the number of woodland patches within a 12 km radius*

Pattern versus proportion (%) of land uses

- The **pattern of surrounding land uses** was a better predictor of little corella presence than the relative proportion (%) of each land use
- *Pattern analysis*: The **best land use predictors** of little corella presence were the number of: 1) **recreation spaces** (i.e. irrigated green spaces); 2) **agricultural properties**; and 3) the number of **residential blocks** within 1 km radius (Appendix 4)
- Proportion (%) analysis: although poorer predictors of presence, the results of this analysis were in agreement with the above pattern analysis

Native vegetation cover

South Australia

- An analysis of native vegetation cover suggested that it was the number of woodland patches within a 12 km radius that was the biggest determinant of little corella presence
- Habitat suitability increased as the number of woodland patches increased indicating a **preference for highly fragment environments**

Mount Lofty Ranges

- The results of our analysis suggested that little corellas generally avoided bushland areas and preferred highly fragmented patches of native vegetation (i.e. vegetation along roads/rivers, surrounding ovals and in council parks and gardens). The best predictor for little corellas was the number of patches of woodland within a 3 km radius at any given point

Appendix 5: List of little corella sites surveyed during the project

Adelaide Aquatic Centre
Adelaide High School ovals
Aldinga Arts Eco Village
Aldinga Football Club
Barossa Tourist Park and ovals
Beautiful Valley Caravan Park
Birdwood High School oval
Birdwood Park, football oval
Bonython Park / Tulya Wardli
Bowman Park and caravan park, Crystal Brook
Bute Rd, Snowtown
Carpark opposite Aldinga Hotel
Christies Beach High School
Christies Beach Primary School
Clayton Bay Boat Club
Clayton Bay Wetlands Caravan Park
Clonlea Park
Collins Reserve, Kidman Park
Corner of Willyaroo Rd and Nine Mile Rd
Coulthard Reserve
Crn Honeypot and Main South Rd
Cruising Yacht Club of South Australia
Crystal Brook grain silos
Curdnatta Park, cricket club on Davies Rd
Eastern Fleurieu School
Eastern Fleurieu School Strathalbyn R-6 Campus
Entrance to Melrose
Evanston Gardens Primary School
Flinders Park Football Club oval
Forsyth Reserve
Gawler & Barossa Jockey Club
Gawler and District College B-12
Gawler Aquatic Centre
Gawler Caravan Park
Gawler Oval Complex
Gawler Primary School
Gawler Railway Station
Goolwa Oval
Goolwa Regatta Yacht Club
Goolwa wharf area
Grange Recreation Oval Reserve
Hackham Football Club
Hawker Golf Course
Hawker Memorial Hospital
Hawker race course
Hewett Primary School
Huntfield Heights Primary School
Imperial Football Club Inc.
Investigator College
Karbeethan Reserve
Keith Stephenson Park
Lakala Reserve
Laratinga Wetlands
Le Messurier Oval
Lockleys oval
Lockleys Reserve
Long Island Reserve, boat marina
Luard St, Milang
Mannum Caravan Park
Mannum Community College oval
Mannum Ferry Terminal
Marcellin Technical College
Market Square Reserve
Mary Ann Reserve
Melrose Caravan and Tourist Park
Melrose Primary School
Middleton Cemetery, Lines Rd
Milang Bowling Club and park area
Milang Football Club
Milang Lakeside Caravan Park
Mount Barker High School
Mount Barker Showgrounds
Mount Barker South Primary School
Mt Barker-Hahndorf Golf Club
Mt Barker-Hahndorf Golf Club
Murray Bridge Golf Club
Murray Bridge High School ovals
Narnungga (Park 25) oval area
Noarlunga Football Club
Noarlunga Private Hospital
North Adelaide Golf Club
North Haven Golf Course
North Haven Primary School OSHC
Nuriootpa Bowling Club
Nuriootpa High School
Nuriootpa Linear Park
Nuriootpa Primary School
Nuriootpa War Memorial Swimming Pool
Oaklands Wetland and Reserve
Ocean View College
Old Noarlunga Primary School
Opposite Leitchs Roseworthy Hotel car park
Palmer western end of town in sugar gums
Pinkerton Creek Rd, Pinkerton Creek
Port Augusta foreshore area
Port Augusta Golf Club
Port Elliot Oval
Port Noarlunga Primary School
Public park on Haines Rd
Public park on Hindmarsh Blvd
Quorn and District Memorial Hospital
Quorn Caravan Park
Quorn Oval
Railway Station Park
Roseworthy grain silos
RSL Recreation Reserve
Sandy Creek Golf Club - Barossa Valley (formerly Gawler Golf Club)
Sandy Creek Primary School
Seaford wetlands
Seaton High School
Small reserve btw Martin St and Mindarie St
Snowtown Primary School
Soldiers Memorial Gardens
Soldiers Memorial Gardens, Middleton
Soldiers Memorial Park (Chase View Tce), Hawker
South Lakes Golf Club Inc.
South Tce opposite Pulteney School
State Sports Park
Stoney Creek, Quorn
Storm water retention basin
Strathalbyn Caravan Park
Strathalbyn cemetery, Parker Av
Strathalbyn Childrens Centre and reserve
Strathalbyn Football Club
Sturt Reserve
Symonds Reserve
Tailem Bend Ferry Terminal
Tailem Bend Golf Course
The Grange Golf Club
The Royal Adelaide Golf Club Inc.
Trinity College Gawler
Two Wells Football & Netball Sporting Club
Two Wells Primary School and Hart Reserve
University of Adelaide Roseworthy Campus
Victor Harbor oval
Victoria Park Racecourse
Virginia Primary School
Virginia Recreation Park, football oval
West Terrace Cemetery
Whispering Wall park area
Wilfred Taylor Reserve
Willaston Cemetery
Williamstown Primary School
Wilmington sports ground

Appendix 6: Using Mental Modeler for the Little Corella project

The Little Corella project is being run by the Discovery Circle, a citizen science initiative at the University of South Australia: http://www.discoverycircle.org.au/

Part of the Little Corella project will use *Mental Modeler* which is an easy-to-use conceptual modelling computer program. It is designed to help individuals and communities identify the components of complex problems. It can also assist users to explore how identified components relate to each other. For the ***Little Corella*** project, we are using this program to:

1. Define components that contribute to problem sites (related to little corellas)
2. Define the strength of the relationships between these components
3. Run scenarios to test how the model might react to a range of possible actions

Tools required

You will need:

- A computer with internet access.
- A compatible internet browser such as *Google Chrome* or *Mozilla Firefox*.
- **Note:** the program does not work in some other internet browsers, like *Internet Explorer*
    - If you want to install *Google Chrome*, it is free to download (click here)
    - If you want to install *Mozilla Firefox*, it is free to download (click here)
    - **Note**: if you are using a work computer, you might need administrator privileges to install new programs.

Instructions

These step-by-step instructions will enable you to open the little corella model that has been sent to you. You will be able to:

(a) add or remove components

(b) define relationships between components

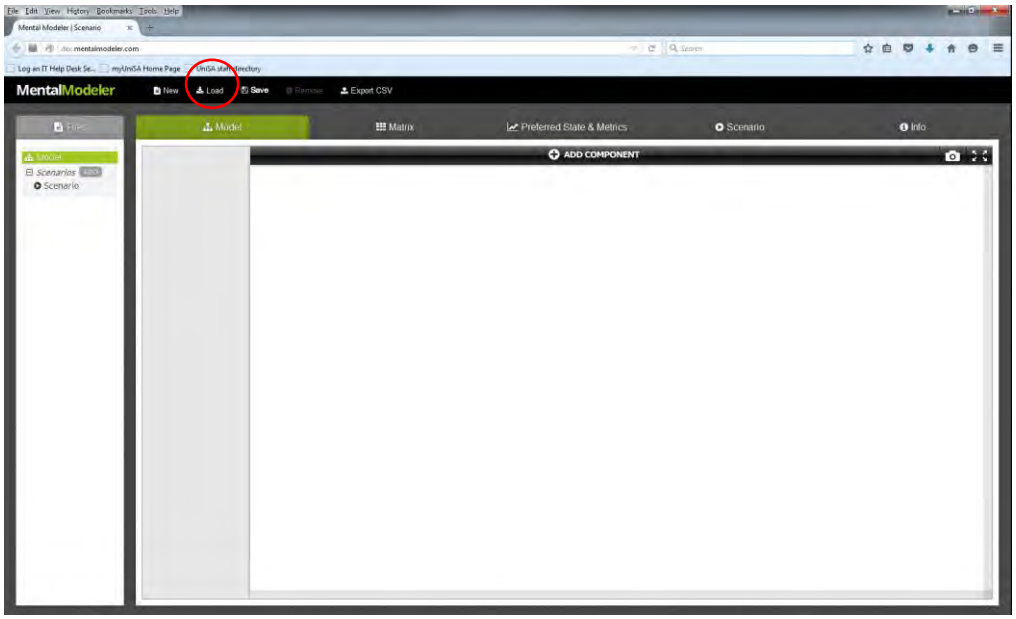
(c) define strengths of these relationships

(d) run your own scenarios

Opening a model in *Mental Modeler*

1. If you are opening a model that was emailed to you, you must first save the file on your computer. The file name will end with the extension type for mental modeller files: **.mmp**
2. Open the online version of *Mental Modeler*, at: http://dev.mentalmodeler.com/

   Note: If you have attended a workshop, you will notice that the online version of the program looks a little different. The online version has a few useful extra features, but the processes to use the program are the same.
3. Click “Load” to open your model, find your saved model, and then click “Open”.



4. The model will appear on the screen and the file name will appear in the “Files” column on the left.

Viewing a model in “full screen” mode

This mode allows a little more space to work.

1. Click on the  icon near the top-right of the screen.
2. A box will appear, asking “Allow full screen with keyboard controls?”
3. Click “Allow”.
4. To exit full screen mode, click “Esc” on your keyboard or click  on the screen.

Adding or removing components

You can add any component that you think is important to the little corrella issue. A component needs to be measurable (i.e. something that can increase or decrease). For example, “trees” could be a measurable component, with the measurement being the number of trees. Importantly, the number of trees can increase or decrease. Components can incude things like:

- Biologial or ecological considerations, such as food, habitat or shelter
- Management considerations, such as deterrents or costs
- Social considerations (for people), such as the amenity of parks, the value of biodiversity, acceptance or anoyance

1. **To add a component:** Click on 

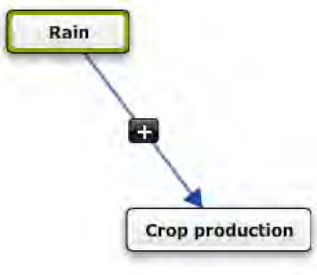
at the top of the screen. Enter a name for the component, use something intuitative that describes the component well (e.g. trees), and move the component around the screen by dragging it with the mouse.
2. **To remove a component:** activate the component by hovering your cursor over it – the component will light up and the icons of a bin (above) and an arrow (below) will appear. Click on the bin to remove the component.

- **Note**: please keep track of the components that you add, or ones that you remove from the original model, because we would like to see your models after you have worked on them.

Adding relationships between components

1. Activate the component by hovering your cursor over it.
2. **Direction of relationship**
   Left click on the arrow icon and hold the mouse button down while you drag the arrow to a second component that you want to link with.

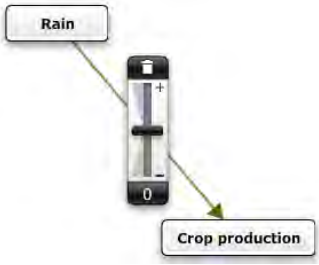
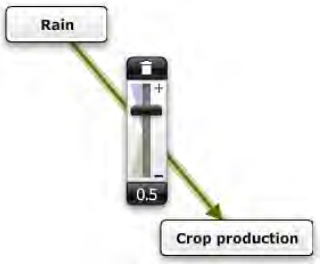
   - **Note**: the arrow defines the direction of the relationship between the components. In the example below, “Rain” has an influence on “Crop production”, but “Crop production” does not influence “Rain”. Therefore the arrow points from rain to crop production. A good rule of thumb when defining relationships is to ask yourself: When One Component increases, does the other component, increase or decrease? In the example below, when rain increases, crops tend to increase.



3. **Strength of relationships**

The strength of the infuence can also be defined. In the online version of *Mental Modeler*, the strength of the relationship is defined using a slide bar (see examples below).A good rule of thumb is to ask whether it increases a lot, a little or decreases a lot or a little.

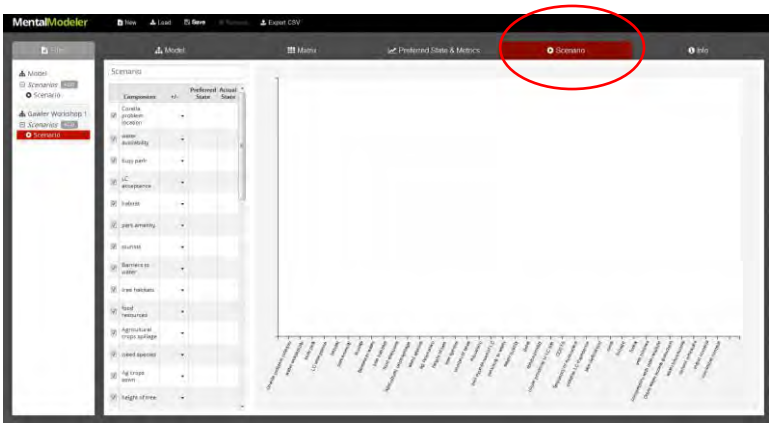
Note: This process is different in the desktop version of Menal Modeler that was used in the Little Corella workshops. The online version allows a more fine-scale adjustment.

EXAMPLE **A**	EXAMPLE **B**	EXAMPLE **C**	EXAMPLE **D**
			
Bar in middle of slide (Strength = **0**)	**Bar at top of slide** (Strength = **1**)	**Bar between middle and top of slide** (Strength = **0.5**)	**Bar at bottom of slide** (Strength = **-1**)
In this example, rain has an affect on crop production, but the strength is not defined	In this example, rain has a highly positive influence on crop production, where heavy rain would be expected to generate high crop production	In this example, rain has an moderately positive influence on crop production, where **heavy rain** would be expected to generate **moderately high** crop production	In this example, rain has an highly negative influence on crop production, where **heavy rain** would be expected to generate **very low** crop production

Running scenarios with *Mental Modeler*

Running scenarios with *Mental Modeler* will give insights into effective management actions (What will work? What are the trade-offs?) For example, in models about little corella problem sites, we would expect that a scenario involving the removal of all trees would also have a negative influence on the little corellas at problem sites. However, such an action would also have consequences elsewhere in the model, like the loss of park amenity and biodiversity. The types of connections between your components will determine how your model behaves under different scenarios.

1. To begin a scenario, click on the "Scenario" tab near the top-right of the screen. In this view, all the components of your model will be listed down the left-hand side of the screen.

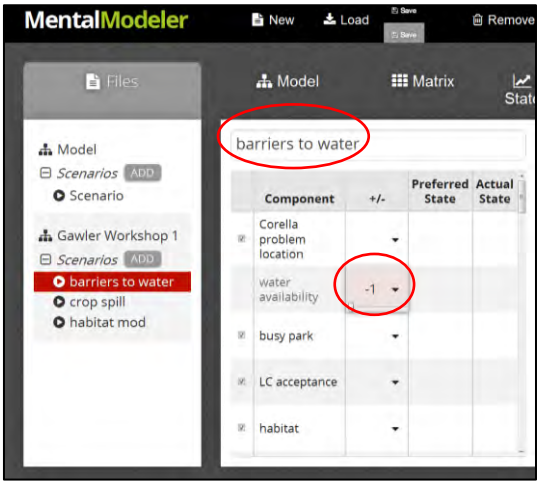


2. In the "Files" column on the left of the screen, click "ADD" to create a new scenario (you can add as many as you like). Above the list of components a space will appear where you can name the scenario – see "barriers to water" in the image below.

3. You can then create a scenario by adjusting the strength and direction of one or more components:

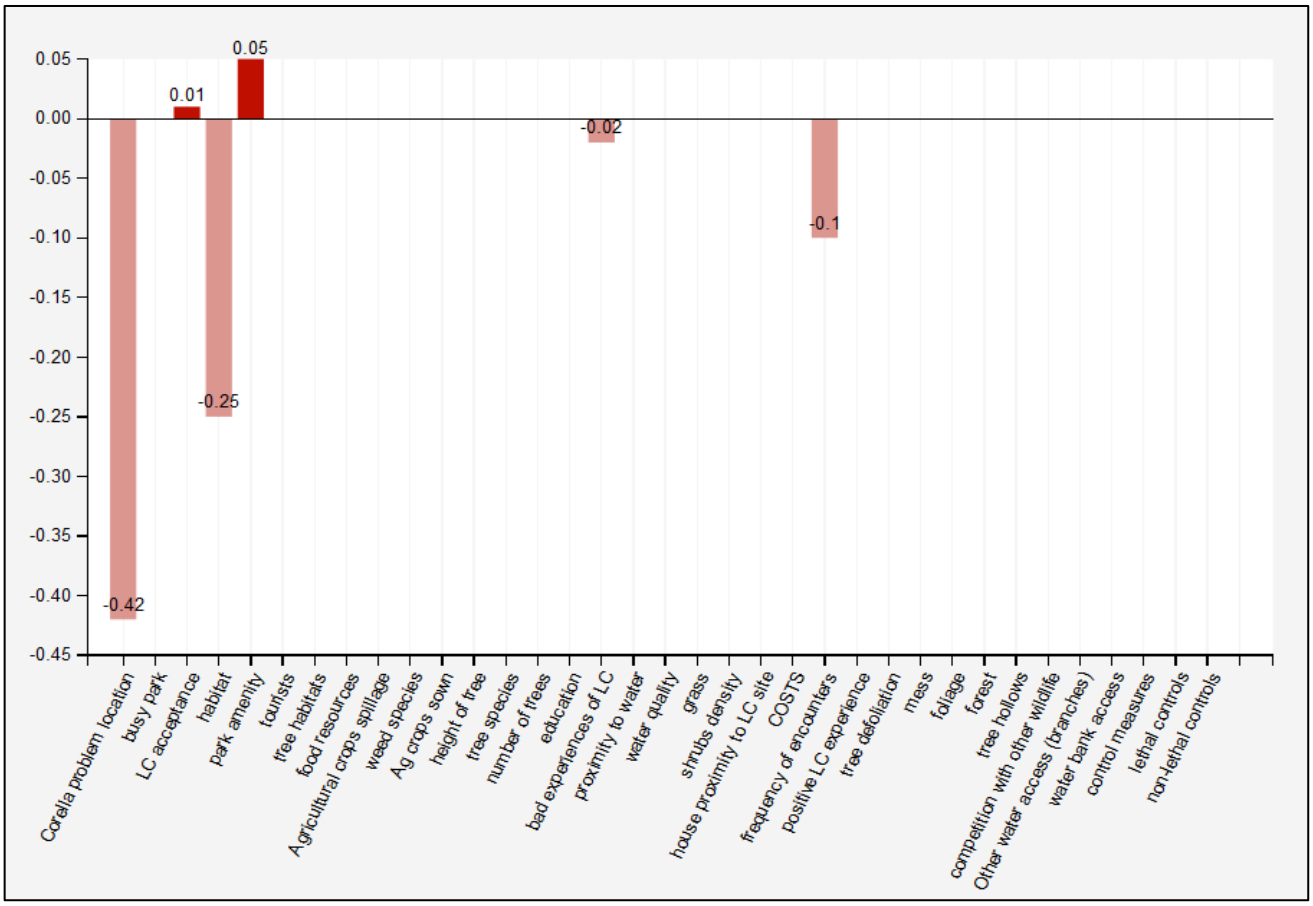
   - In the +/- coloum, click on the arrow corresponding to the component that you want to adjust and a slide bar will appear.
   - Move the slide bar to indicate the change of relationship that you want. A graph will appear (and update automatically) as you manipulate the components.

4. Once you have created scenarios, you can use the "File" column on the left of the screen to look at each scenario or move back to the model.



Interpreting the scenarios

The example below was generated using a model from a trial workshop. A scenario was created where "water availability" was reduced as much as possible. The columns in the graph indicate where the trade-offs occured under this scenario. You can see that the *Corella probem locations* were decreased. Other components that decresed under this scenario were *habitat*, *bad experiences of little corellas*, and *frequency of encounters*. Conversely, two components increased, namely *Little corella acceptance* and *park amenity*.

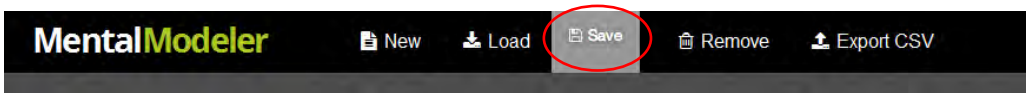


Note: When evaluating the scenarios, it is helpful to consider what the future might look like under the conditions you have set. If your scenario results are counter to your intuitive understanding, it could mean your model needs to be refined. You can go back and check:

- If a relationship between components has been overlooked (e.g. perhaps a connection needs to be added).
- If the relationships between the variables are correct (e.g. perhaps there is a positive relationship when a negtive relationship is more appropriate).
- If the strengths of the relationships are correct. Adjustments in the strengths of relationships can have a surprising influence on outcomes of scenarios.

Saving your model

1. Click the “Save” tab at the top screen.



2. You will be asked to name the file and choose a location to save it in. Change the File name to include your surname and the date, for example:

Scanlon 12 Dec 2015.mmp

3. **Note**: the default file name will have “.mmp.mmp” at the end. You only need one .mmp at the end of your file name (you can delete the other one).

4. Please send the file to us (e-mail: discoverycircle@unisa.edu.au); we would appreciate a short summary of the changes that you have made (e.g. new components, plus interesting scenarios or observations about the model). Thank you!!

Additional resources for *Mental Modeler*

- ***Mental Modeler***: http://www.mentalmodeler.org/#resources
- **Discovery Circle**: http://www.discoverycircle.org.au/

Discovery Circle