

Muir's Corella (*Cacatua pastinator pastinator*) Recovery Plan



Australian Government



Department of
Environment and Conservation

Our environment, our future



**MUIR'S CORELLA (*Cacatua pastinator*
pastinator) RECOVERY PLAN**

2008

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FOREWORD

Recovery Plans are developed within the framework laid down in Department of Environment and Conservation (DEC) Policy Statements Nos 44 and 50.

Recovery Plans delineate, justify and schedule management actions necessary to support the recovery of threatened species and ecological communities. The attainment of objectives and the provision of funds necessary to implement actions is subject to budgetary and other constraints affecting the parties involved, as well as the need to address other priorities. Recovery Plans do not necessarily represent the views or the official position of individuals or organisations represented on the Recovery Team.

This Recovery Plan was approved by the Department of Environment and Conservation. Approved Recovery Plans are subject to modification as dictated by new findings, changes in status of the taxon or ecological community and the completion of recovery actions. The provision of funds identified in this Recovery Plan is dependent on budgetary and other constraints affecting the Department, as well as the need to address other priorities.

Information in this Recovery Plan was accurate on 16 January 2009.

RECOVERY PLAN PREPARATION

This Recovery Plan was prepared by Tamra Chapman (Zoologist) and Belinda Cale (Project Officer) of the Department of Environment and Conservation (DEC, formerly Department of Conservation and Land Management), for the Muir's Corella Recovery Team. Ken Atkins, John Blyth (now retired) and Peter Mawson (Department of Environment and Conservation) reviewed the Recovery Plan and Tony Kirkby (Western Australian Museum) provided the cover photograph.

SUMMARY

Muir's Corella *Cacatua pastinator pastinator* Gould 1841

Family:	Psittacidae
DEC Regions:	Warren, Wheatbelt
DEC Districts:	Frankland, Donnelly, Katanning
Recovery Team:	Muir's Corella Recovery Team
Current status of taxon:	Endangered
Breeding habitat:	Nests in the hollows of mature live eucalypts (often lone trees in paddocks or along roadsides)
Feeding habitat:	Mainly feeds on the corms of the introduced 'Guildford Grass' or 'Onion Grass' <i>Romulea rosea</i> , <i>Drosera</i> spp., Orchids, seeding Oat <i>Avena sativa</i> , Winter Grass <i>Poa annua</i> and Clover
Habitat critical for survival:	The habitat critical to survival and important populations of Muir's Corella comprises large live or dead eucalypts, particularly Marri <i>Corymbia calophylla</i> and Jarrah <i>Eucalyptus marginata</i> , Flooded Gum <i>Eucalyptus rudis</i> , Yate <i>Eucalyptus cornuta</i> and Paperbark <i>Melaleuca preissiana</i> in forested areas or as lone trees in paddocks and along roadsides in the region from Boyup Brook, McAlinden and Qualeup, south to Lake Muir and the lower Perup River, and east to Frankland and Rocky Gully.

Recovery plan objective

To stop any further decline in the distribution and abundance of Muir's Corella in the south-west of Western Australia.

Criteria for success

This Recovery Plan will be successful if the extent of occurrence is not less than 8,000 km² and the number of birds counted in ground surveys is not less than 1,000.

Criteria for failure

This Recovery Plan will be unsuccessful if the extent of occurrence falls below 8,000 km² and the number of birds counted in ground surveys is less than 1,000.

Recovery Actions

- 11.1 Seek the funding required to implement future recovery actions.
- 11.2 Determine population numbers, distribution and movements.
- 11.3 Identify factors affecting the number of breeding attempts and breeding success and manage nest hollows to increase recruitment.

- 11.4 Map feeding and breeding habitat critical to survival and all wild and translocated populations, and prepare management guidelines for these habitats.
- 11.5 Revegetate with favoured hollow-bearing trees.
- 11.6 Determine and implement ways to remove feral Honeybees from nesting hollows.
- 11.7 Produce an information kit to help eliminate illegal killing and distribute to the wider community.
- 11.8 Prevent the spread of non-endemic Corella populations in south-west Western Australia.
- 11.9 Collect DNA samples and analyse to determine the taxonomic status of *Cacatua pastinator* subspecies.

Cost: \$416,000 over 10 years.

1. INTRODUCTION

1.1. History and taxonomic relationships

The Western Long-billed Corella *Cacatua pastinator* is comprised of two geographically isolated sub-species (Figure 1, Higgins 1999). Butler's Corella *Cacatua pastinator butleri* occurs in the northern wheatbelt of Western Australia (Ford 1985, 1987; Johnstone and Storr 1998). Muir's Corella *Cacatua pastinator pastinator* is confined to the south-west of Western Australia near Lake Muir (Johnstone and Storr 1998; Higgins 1999). Schodde and Mason (1997) used the name *C. pastinator derbyi*, not *C. pastinator butleri*, but this is believed to be incorrect because of confusion about the provenance of the type specimen, which is held in the American Museum of Natural History (personal communications R. Johnstone¹). Muir's Corella can be confused with the Little Corella *C. sanguinea*, but Muir's Corella has a longer upper mandible, is larger, has orange-red lores and has a more intense yellow on the underparts of the wings and tail than the Little Corella (Higgins 1999).

This Recovery Plan focuses on the southern subspecies, Muir's Corella *Cacatua pastinator pastinator*. Other names previously used for this species include Bare-eyed Corella, Western Long-billed Corella, Dampier's Corella, White Cockatoo and Corella (Higgins 1999).

1.2. Description

Muir's Corella is larger in size than the northern subspecies (Ford 1987). Adults are 43-48 cm in length and 560-815 g in weight (Johnstone and Storr 1998). A medium sized, stocky cockatoo, Muir's Corella has broad rounded wings, a short tail and a crest that is usually flattened (Higgins 1999). It has a dark brown iris and bluish-grey bare skin around the eye (Johnstone and Storr 1998). This eye skin is larger below, than above, the eye (Higgins 1999). The bill is a dull greyish white, the legs are dark grey and the upper mandible has a long tip (Johnstone and Storr 1998). The underparts are often stained or dirty (Johnstone and Storr 1998) as a result of feeding on the ground and digging (Higgins 1999).

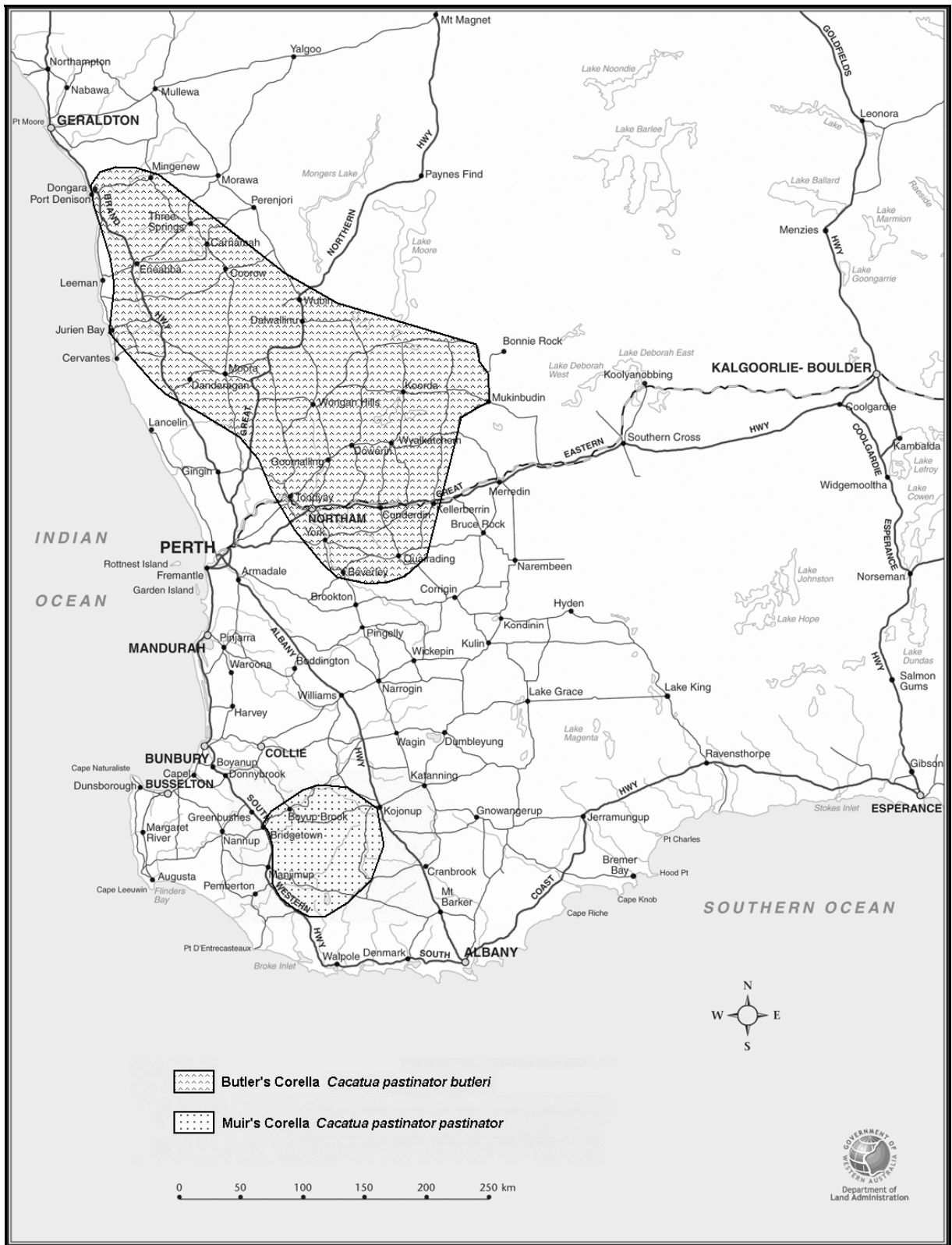


Figure 1 Distribution of Butler's Corella *Cacatua pastinator butleri* and Muir's Corella *Cacatua pastinator pastinator* (map produced by the authors based on information taken from Johnstone and Storr (1998)).

1.3. Range and abundance

This species once inhabited most of the south-west of Western Australia from the Swan River and Avon River to Augusta and Broomehill (Johnstone 1997; Schodde and Mason 1997). Muir's Corella was last reported southeast of Broomehill in 1913, further east at Gnowangerup in 1913 and near Augusta in 1916 (Carter 1924; Storr 1991). By the 1920s, its range had contracted to the Lake Muir region (Carter 1924). Casual sightings were recorded southeast of Bridgetown in 1933 (Whittell 1933), at Mandurah in 1944 (Serventy and Whittell 1976) and at Dumbleyung in 1956 (Storr 1991). The exploitation of the cereal crops during the late 1800s and early 1900s resulted in the widespread poisoning and shooting of Muir's Corella (Moore 1884; Carter 1912). This persecution was considered to be responsible for the rapid decline in its range and numbers (Carter 1912). The population declined to around 100 birds in the 1940s but had increased to around 1,000 by 1978 (Saunders *et al.* 1985; Smith 1991). At Lake Muir, the population was estimated at 100 birds in 1921 (Alexander 1921) and around 600 birds in 1966 (personal communications R. Johnstone¹).

The Muir's Corella population appears to have slowly increased in range and number over the past 40 years. For example, the population increased from an estimated 1,000 birds in 1978 (Saunders *et al.* 1985) to around 3,000 birds during surveys conducted between 1985 and 1995 (personal communications R. Johnstone¹). In the 1970s, large summer flocks were observed east of Boyup Brook (Smith and Moore 1992) and in 1985, flocks of up to 1,000 were observed at Dinninup and Orchid Valley (personal communications R. Johnstone¹). From 1990 to 1999, flocks of more than 100 birds were observed at Tonebridge, Mordalup, Chowerup, Bokerup, Rocky Gully and Lake Muir (Massam and Long 1992).

Muir's Corella is now confined to a small region from Boyup Brook, McAlinden and Qualeup, south to Lake Muir and the lower Perup River, and east to Frankland and Rocky Gully (Storr 1991; Massam and Long 1992). It is locally common on farmland, but patchily distributed (Johnstone and Storr 1998). The total population is not precisely known because counts have varied widely, suggesting that some birds may occur on private land where they cannot be counted (personal communications R. Johnstone¹). However, the population is estimated at between 1,500 to 3,000 birds from regular surveys (Massam and Long 1992; personal communications R. Johnstone¹).

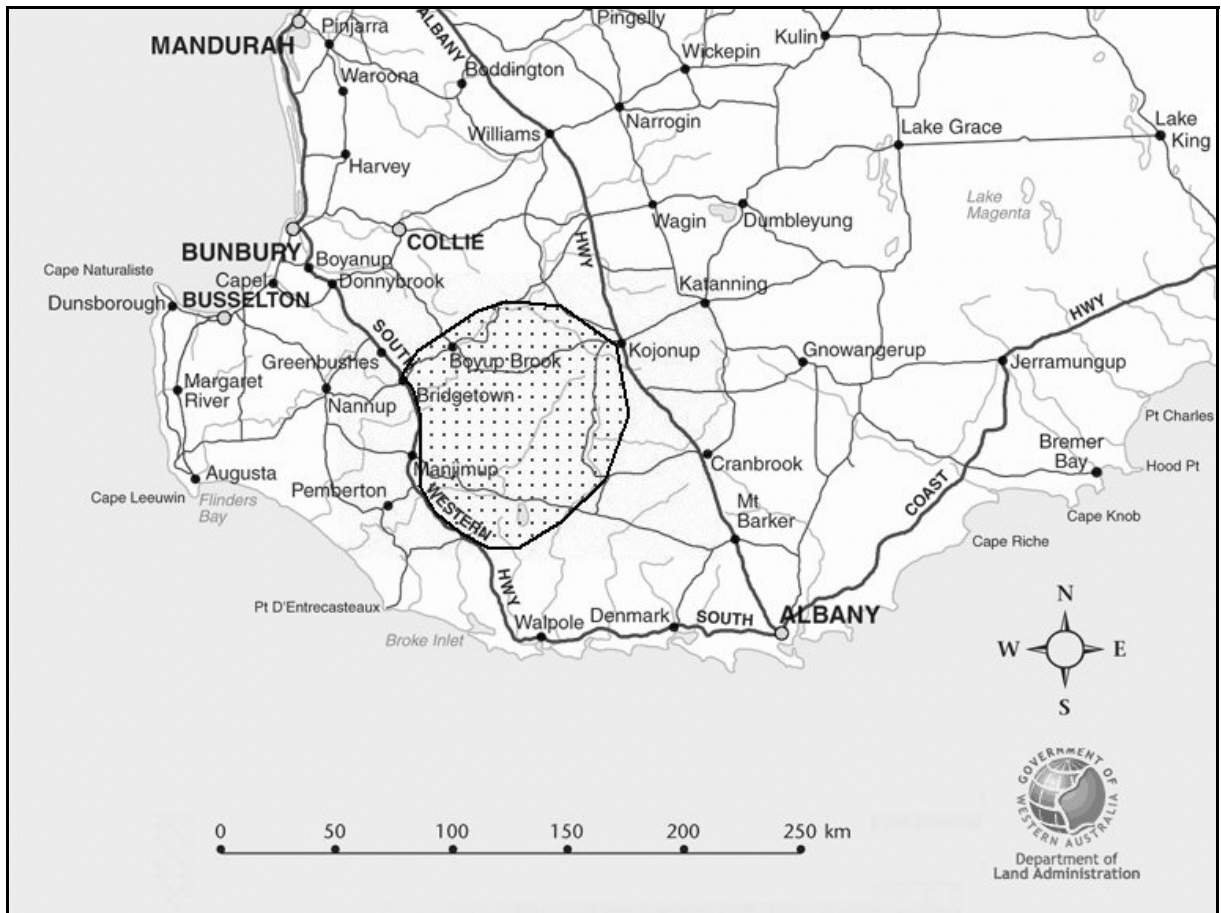


Figure 2 Distribution of Muir's *Corella Cacatua pastinator pastinator* for south-west Western Australia (map produced by the authors based on information taken from Johnstone and Storr (1998)).

1.4. Feeding and breeding

Muir's Corella feeds on corms, tubers and seeds from a variety of introduced and native plant species, and insect larvae (Higgins 1999). Its long bill is efficient for digging corms and tubers from the ground and it will dig up newly planted and germinating wheat and oats (Higgins 1999). It also feeds on grain amongst stubble and in cattle feed-lots (Higgins 1999). Analysis of 18 crops collected during winter in the Unicum area revealed that Muir's Corella predominantly ate corms of the introduced 'Guildford Grass' or 'Onion Grass' *Romulea rosea* (Smith and Moore 1991). It also ate moderate amounts of Oat *Avena sativa* and Winter Grass *Poa annua* seed (Smith and Moore 1991). *Romulea rosea* appeared to form the bulk of the diet from May to November, while cereal grains, including Oats, Barley *Hordeum vulgare* and Wheat *Triticum aestivum*, were commonly eaten during the remainder of the year (Smith and Moore 1991). Other introduced plant species eaten by Muir's Corella included *Erodium* spp., tubers of Nut Grass *Cyperus rotundus*, Clover *Trifolium* spp. and Curled Dock *Rumex crispus* (Smith and Moore 1991). Muir's Corella has been reported causing damage to horticulture crops such as cabbages and tree seedlings in revegetated plots (personal

communications M. Massam²). The native plant species eaten by Muir's Corella include the bulbs of Sundews *Drosera* spp. (Carter 1912), the roots of 'orchidaceous plants' (Serventy and Whittell 1976) and the seeds of Marri *Corymbia calophylla* and Spear Grass *Stipa* spp. (Smith and Moore 1991).

Muir's Corella nests in hollows found in large live or dead eucalypts, particularly Marri and Jarrah *Eucalyptus marginata* (Carter 1912; Mawson and Long 1994; Johnstone and Storr 1998). Some breeding has also been recorded in Flooded Gum *Eucalyptus rudis*, a species of Yate *Eucalyptus cornuta* (R. Johnstone¹ unpubl. data) and Paperbark *Melaleuca preissiana* (personal communications P. Mawson³). Muir's Corella prefers to nest in live trees, which typically have dead limbs and an open canopy (Mawson and Long 1994), and it removes bark from around the entrance of the hollow (Johnstone and Storr 1998).

Nesting trees are situated in woodland remnants, on the edge of forested areas or as lone trees in paddocks and along roadsides (personal communications R. Johnstone¹). The height of the nest is 6 to 20 m above the ground, the hollow entrance is 15 to 40 cm wide and the hollow is 0.5 to 2 m deep (Johnstone and Storr 1998). Muir's Corella may compete with other cockatoo species, feral Honeybees *Apis mellifera*, Australian Shelducks *Tadorna tadornoides* and Australian Wood Ducks *Chenonetta jubata* for the use of tree hollows (personal communications R. Johnstone¹). In addition, some hollows may be at risk of flooding during the breeding season (personal communications R. Johnstone¹).

The breeding biology of Muir's Corella has been studied by Ron Johnstone, Curator of Birds at the Western Australian Museum. Most of the known nests are located in lone trees in paddocks or along roadsides (personal communications R. Johnstone¹). The breeding habitat occurs on private property, particularly near Rocky Gully, Lake Muir and Tonebridge / Mordalup (personal communications R. Johnstone¹). Eggs are laid from September to November and the clutch size ranges from one to four eggs (Johnstone and Storr 1998; G. Smith⁴ unpublished data). The incubation period is 26 to 29 days (Johnstone and Storr 1998). For the nests of Muir's Corella monitored near Unicup in 1977, mean clutch size was three and the mean number fledged was 0.9 per nest ($n = 9$ nests, G. Smith⁴ unpublished data).

Survival rates of adult and immature Muir's Corellas are unknown, but factors known to cause mortality, particularly of immature birds, include predation by Falcons *Falco* spp. (Smith and Rowley 1995) or other birds of prey, road deaths and shooting or poisoning by humans

(Garnett and Crowley 2000). Longevity is unknown for wild birds, but is up to 26 years for captive *C. pastinator* subspecies (Brouwer *et al.* 2000).

1.5. Biology and ecology

Strongly gregarious, Muir's Corella forages and roosts in small groups or flocks of hundreds of individuals (Higgins 1999). These flocks are widely distributed, probably because of the patchy distribution of suitable habitat within their range (Smith 1982). During the breeding season, the nest tree is the focus of activity, and feeding takes place nearby (Higgins 1999). After fledging, the young and their parents are joined by other family groups and immature birds (Higgins 1999). These flocks may then disperse to suitable summer feeding sites (Higgins 1999). For example, nestlings from the Unicup area moved to an area east of Boyup Brook in summer, returning to Unicup in early March (Smith and Moore 1992). These summer flocks may be comprised of flocks from a number of breeding districts (Smith and Moore 1992), sometimes forming flocks of up to 1,000 individuals (Johnstone and Storr 1998). Breeding adults return to their breeding district at the end of summer (Higgins 1999). Immature birds form locally nomadic flocks that may return to their natal area or remain in the summer feeding district (Smith and Moore 1992).

1.6. Conservation status

Muir's Corella is listed as 'rare or likely to become extinct' pursuant to the Western Australian *Wildlife Conservation Act 1950*. It has been ranked as Endangered by the Western Australian Threatened Species Scientific Committee using IUCN (2001) Red List Categories and Criteria, meeting Criterion C2b. This ranking has been endorsed by the Western Australian Minister for the Environment. The subspecies meets Criterion C for Endangered because the number of mature individuals is fewer than 2,500 and all individuals occur in a single sub-population. Muir's Corella is listed as Vulnerable under Section 178 of the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*.

2. HABITAT CRITICAL TO SURVIVAL AND IMPORTANT POPULATIONS

Habitat means the biophysical medium or media: (a) occupied (continuously, periodically or occasionally) by an organism or group of organisms; or (b) once occupied (continuously, periodically or occasionally) by an organism, or group of organisms, and into which

organisms of that kind have the potential to be reintroduced (*Environment Protection and Biodiversity Conservation Act 1999*).

Habitat critical to survival and important populations of Muir's Corella comprises areas:

- currently occupied by Muir's Corella
- not currently occupied by Muir's Corella due to recent fire but capable of supporting populations when sufficiently recovered
- of natural vegetation in which Muir's Corella nests, feeds and roosts
- of natural vegetation through which Muir's Corella can move from one occupied area to another, and
- of suitable vegetation within the recorded range in which undiscovered Muir's Corella populations may exist.

The habitat critical to survival and important populations of Muir's Corella comprises large live or dead eucalypts, particularly Marri *Corymbia calophylla* and Jarrah *Eucalyptus marginata*, Flooded Gum *Eucalyptus rudis*, Yate *Eucalyptus cornuta* and Paperbark *Melaleuca preissiana* in forested areas or as lone trees in paddocks and along roadsides in the region from Boyup Brook, McAlinden and Qualeup, south to Lake Muir and the lower Perup River, and east to Frankland and Rocky Gully.

3. GUIDE FOR DECISION MAKERS

Section 4 provides details of current and possible future threats to Muir's Corella.

Developments in the immediate vicinity of the population or within the habitat that is defined as critical to survival require assessment. Any on-ground works (clearing, firebreaks, roadwork, burning, drainage etc.) in the immediate vicinity of Muir's Corella habitat will require assessment for potentially significant levels of impact.

4. THREATS

The threatening processes for Muir's Corella are killing by illegal shooting and poisoning, habitat loss, changes in land use, nest hollow shortage, competition for available nest hollows

and killing by feral Honeybees *Apis mellifera*. Climate change is an additional threat that is likely to exacerbate the threatening processes as a result of changes to biodiversity and ecosystem function (Chambers *et al.* 2005). As Muir's Corella occurs in a single population, the entire population is affected by these threats.

4.1. Killing by shooting and poisoning

Muir's Corella damages newly sown grain crops, horticultural crops, seedling trees in plantations, home gardens, television aerials and power lines (personal communications M. Massam²). The subspecies also consumes stock feed, particularly in the summer months, and causes excessive noise around rural households (personal communications M. Massam²). In the early 1900s, Muir's Corella was considered a pest of agriculture, because it is a grain eating bird, and it was shot and poisoned by farmers (Carter 1912; Saunders *et al.* 1985). It is currently listed as a Declared Pest of Agriculture (Category A7 of the *Agriculture and Related Resources Protection Act 1976*, administered by the Western Australian Department of Agriculture and Food) in the Shires of Boyup Brook, Cranbrook and Manjimup. Category A7 means that a management programme outlines the area and conditions under which controls may be applied (*List of Declared Animals, 18 November 2005*) pursuant to the State *Agriculture and Related Resources Protection Act 1976*.

Shooting and poisoning of Muir's Corella is no longer permitted in Western Australia and this has resulted in a recovery in total population size (Massam and Long 1992; Johnstone 1997). Damage licences to 'shoot to scare' may still be obtained from the Department of Environment and Conservation, under the provisions of the State *Wildlife Conservation Regulations 1970*. However, birds are still shot illegally, particularly in areas where stock are fed with grain (Garnett and Crowley 2000).

4.2. Habitat loss and changes in land use

Much of the original feeding and breeding habitat of Muir's Corella has been lost due to clearing for agriculture, soil salinisation and changes to soil and vegetation structure by stock (Garnett and Crowley 2000). In addition, as the logging industry in south-west forests declines, the farm land on which Muir's Corella occurs is now being converted to Blue Gum *Eucalyptus globulus* plantations (Garnett and Crowley 2000). Broadscale clearing for plantations results in the loss of nest hollows and related land management practices can also limit the availability of food (Garnett and Crowley 2000). Clearing of nest trees for

agriculture and hardwood plantations has caused a decline in the availability of nest hollows for Muir's Corella (Smith 1991; Mawson and Long 1994).

4.3. Nest hollow competition

Competition for nest sites with other birds and the feral Honeybee *Apis mellifera* is a significant threatening process for Muir's Corella (personal communication R. Johnstone¹). The feral Honeybee can form long-term hives in tree hollows and can kill nesting females and chicks in the nest by stinging (personal communication R. Johnstone¹). The threat posed by feral Honeybees is also likely to increase with the southward movement of bees in response to change to a warmer climate in Western Australia.

4.4. Introduced corellas

The Little Corella *Cacatua sanguinea* and the Eastern Long-billed Corella *Cacatua tenuirostris* are not endemic to Western Australia, but around 3,000 birds have become established around Perth (Blyth 2004) as a result of aviary escapes. The birds have increased in range and number from about 960 in 1998 to about 3,000 in 2004 (Blyth 2004). Flocks of introduced corellas have also been recorded outside the Perth metropolitan area in the regional centres of Mandurah, Bunbury, Busselton and Albany (Blyth 2004). These corellas pose a threat to Muir's Corella because they have similar feeding and breeding requirements (Garnett and Crowley 2000). In addition, if their populations spread into the range of Muir's Corella, these species could potentially interbreed (Garnett and Crowley 2000). Similarly, the southward spread of the Butler's Corella could threaten the feeding and breeding resources and the genetic integrity of Muir's Corella (personal communication P. Mawson³).

5. INTERNATIONAL OBLIGATIONS

All parrots and their allies in the Order Psittaciformes, including *Cacatua* spp., are listed on Appendix II of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). Australia is a member country to CITES and thus has an obligation to ensure that international trade in specimens of these species does not threaten their survival (CITES 1973). Appendix II of CITES allows international trade in live wild-caught and captive-bred specimens, if such exports are not detrimental to wild populations (CITES 1973).

6. AFFECTED PARTIES

The main parties likely to be affected by this Recovery Plan are: Department of Environment and Conservation; Department of Agriculture and Food; Western Australian Museum; woodlot plantation companies and private landholders. The means by which these parties will be involved in the implementation of the Recovery Plan will be discussed in Section 11.

7. INDIGENOUS PEOPLE

The Department of Environment and Conservation will consult with Indigenous communities in the regions identified in this plan. Implementation of recovery actions under this plan will include consideration of the role and interests of Indigenous communities in the region. Input and involvement will be sought from any Indigenous groups that have an active interest in areas that form the habitat of Muir's Corella. The Aboriginal Sites Register, maintained by the Department of Indigenous Affairs, does not list any significant sites in the vicinity of these populations. However, not all significant sites are listed on the Register.

8. BENEFITS

The conservation of the feeding and breeding habitat of Muir's Corella depends on the protection and management of natural resources in the Warren subregion and parts of the Southern Jarrah Forest subregion of Western Australia (see May and McKenzie 2003). These ecosystems are under threat from vegetation clearing, fragmentation, loss of remnants, lack of regeneration, exotic weeds, changing fire regimes, altered hydrology, urbanisation and dieback *Phytophthora cinnamomi* (Hearn *et al.* 2003a; Hearn *et al.* 2003b). The subregions contain rare and priority flora, threatened ecological communities and threatened fauna (Hearn *et al.* 2003a; Hearn *et al.* 2003b). These fauna carry out essential ecosystem functions and thereby contribute to the maintenance of biodiversity. Thus, recovery actions carried out to conserve the habitat of Muir's Corella are likely to improve the status of the Warren and Southern Jarrah Forest subregions as well as rare and priority flora, threatened ecological communities and threatened fauna. This would make a considerable contribution to the maintenance of Western Australia's and Australia's biodiversity.

9. SOCIAL AND ECONOMIC IMPACTS

If numbers of Muir's Corella increase, the costs of damage management to landholders and Departments of Environment and Conservation and Agriculture and Food may also increase.

Conversely, however, if sufficient feeding and breeding resources can be protected for Muir's Corella, the bird may be less likely to feed on grain crops and cause damage in agricultural areas. Thus, the economic costs of pest management of Muir's Corella to farmers, the general community, the Departments of Environment and Conservation and Agriculture and Food are likely to be reduced. In addition, although Muir's Corella can cause damage to revegetated tree seedlings and grain crops, most farmers on whose land the corella occurs value the birds as a threatened species (authors' observations). Thus, since Muir's Corella has a social and biodiversity value in the small region in which it occurs, the social and regional benefits of its recovery will be enhanced by the implementation of this Recovery Plan.

10. RECOVERY OBJECTIVE AND CRITERIA

The objective of this Recovery Plan is to stop the decline in the Muir's Corella population within 10 years by ensuring the subspecies maintains a population of not less than 1,000 birds counted in ground surveys.

The average life expectancy of Muir's Corella is thought to be 14 to 25 years, and adults breed at three to five years of age (Smith 1991; Brouwer *et al.* 2000; Rowley and Mawson 2001). It is also likely that Muir's Corella is long-lived with a generation time greater than 10 years (personal communications R. Johnstone¹). Therefore, down listing from endangered to vulnerable within the 10-year time frame of this Recovery Plan seems unlikely.

10.1. Criteria for success

This Recovery Plan will be successful if the extent of occurrence is not less than 8,000 km² and the number of birds counted in ground surveys is not less than 1,000.

10.2. Criteria for failure

This Recovery Plan will be unsuccessful if the extent of occurrence falls below 8,000 km² and the number of birds counted in ground surveys is less than 1,000.

10.3. Management and evaluation

A Muir's Corella Recovery Team was appointed in 1999 to coordinate the recovery of Muir's Corella and the development and implementation of the Recovery Plan. The Western Australian Department of Environment and Conservation, in consultation with the Muir's

Corella Recovery Team, will evaluate the performance of this Recovery Plan. The plan will be reviewed within five years of its implementation. The recovery actions carried out and any changes to management and recovery actions will be documented accordingly. In accordance with the provisions of the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) this adopted recovery plan will remain in force until revoked. The recovery plan must be reviewed at intervals of not longer than 5 years.

10.4. Existing conservation measures

The nesting and breeding biology of Muir's Corella has been studied by Ron Johnstone, Curator of Birds at the Western Australian Museum, since 1996. Between March 1999 and December 2001, 21 nest boxes were erected to determine whether this species will use artificial nesting hollows. However, few of the hollows were used for nesting and the corellas would be more likely to benefit from the removal of feral Honeybees from existing potential nest hollows than from providing artificial hollows (personal communications R. Johnstone¹).

Ground surveys were carried out two to four times a year by the Western Australian Museum from 1985 to 2002. A distribution map is being prepared from the Western Australian Museum database. Biennial aerial surveys were conducted jointly by the Departments of Agriculture and Conservation and Land Management from 1990 to 1999 and again in 2002. The results of these surveys showed that ground surveys were more likely to be effective in recording the number and distribution of Muir's Corella than aerial surveys. As a result, the Department of Environment and Conservation's Warren Region now conducts four ground surveys per year. The aim of these surveys is to record total population size, distribution and seasonal movements.

A captive-breeding program for Muir's Corella was initiated by the Department of Conservation and Land Management in 1995. The program currently involves DEC, Perth Zoo and licensed aviculturists. In 1998, seven birds were held at Perth Zoo and four were held on long-term loan to a researcher. In 1999, three birds were collected from the wild, in 2000 an additional nine birds were collected and in 2001 a further seven birds were collected. As of June 2004, 24 of the total of 30 birds collected remained alive. The objective of the captive-breeding program is to promote sustainable use of wildlife and to reduce poaching, thereby minimising the risk of nest hollow damage (personal communications P. Mawson³). Two chicks that hatched on 20 October 2003 and two chicks that hatched on 22 October 2004

died within two months of hatching (Perth Zoo unpubl. data). They were found dead in the nest box and records from Perth Zoo showed that one may have been attacked by a parent.

Perth Zoo, the Western Australian Museum and the Departments of Agriculture and Food and Environment and Conservation have established a public awareness program for the general public and farmers. These materials explain that although Muir's Corella can cause damage on farms, it is protected and endangered. These Departments also provide landholders with details on a range of methods that may be used to prevent damage by corellas to agricultural crops and property. The Western Australian Museum also has a school education kit called 'Threatened Species' which mentions Muir's Corella.

11. RECOVERY ACTIONS

The recovery actions are presented in order of descending priority but this should not prevent the implementation of 'lower' priority actions where opportunities arise and funding is available. Where flocks occur on lands other than those managed by DEC, permission has been or will be sought from the managers prior to recovery actions being undertaken.

11.1. Seek the funding required to implement future recovery actions.

The recovery team will investigate sources of funding and attempt to secure the funding required to implement these actions. This process will be ongoing.

Action: Seek the funding required to implement future recovery actions

Responsibility: DEC

Completion date: Ongoing

Cost: In kind labour to prepare funding applications.

11.2. Determine population numbers, distribution and movements.

Muir's Corella is restricted to a small area of south-west Western Australia at Lake Muir, Tonebridge / Mordalup, Rocky Gully and north of Chowerup (Johnstone and Storr 1998). This population has been monitored using both aerial and ground surveys. Ground surveys have proven to be more effective than aerial surveys for estimating the number of birds in the population (personal communications P. Mawson³). Ground surveys provide estimates of population size, distribution and seasonal movements. This allows the effectiveness of recovery actions to be assessed.

Ground surveys will be carried out quarterly by DEC Warren Region staff. The surveys will monitor the number of birds in each flock, distribution and seasonal movements to determine if any changes occur in the range of this subspecies. Where possible, DEC staff will also establish and maintain a program of community involvement in the monitoring of Muir's Corella. The results of the surveys will be reported to Recovery Team members, local landholders and the local community via the media.

Action: Determine population numbers, distribution and movements

Responsibility: DEC Warren Region

Completion: Ongoing

Cost: \$250,000 (\$25,000 per year: \$10,000 salaries plus \$15,000 vehicle costs per year)

11.3. Identify factors affecting the number of breeding attempts and breeding success and manage nest hollows to increase recruitment.

Although the breeding biology of Butler's Corella has been investigated (e.g. Smith 1991), less is known about the breeding biology of Muir's Corella (Higgins 1999). Continued research into the breeding biology of this species will provide important information on nesting requirements and factors limiting nesting success.

Research will continue to document nest hollow requirements and breeding success in this species. Active nest hollows will be identified and monitored annually at selected sites. The objectives of this research will be to: record information on nest trees, clutch size, incubation and fledging periods, breeding behaviour and movements of the corellas. Staff from the Western Australian Museum will, where possible, repair and maintain natural hollows and remove feral Honeybees from hollows. The results of these studies will be reported to the Recovery Team and published in an appropriate scientific journal.

Action: Identify factors affecting the number of breeding attempts and breeding success and manage nest hollows to increase recruitment

Responsibility: Western Australian Museum

Completion: Year four

Cost: \$20,000 (\$5,000 per year for four years)

11.4. Map feeding and breeding habitat critical to survival and all wild and translocated populations, and prepare management guidelines for these habitats.

Muir's Corella feeds on the corms of the introduced 'Guildford Grass' or 'Onion Grass', *Drosera* spp., Orchids, seeding Oat, Winter Grass and Clover (Johnstone and Storr 1998). It breeds in the hollows of eucalypts, particularly Marri and Jarrah (Johnstone and Storr 1998).

The majority of feeding and breeding sites occur on private property, along road verges and on the edge of forested areas (Johnstone and Storr 1998).

Although a general description of the feeding and breeding habitat of Muir's Corella has been given in this Recovery Plan, adequate maps of the feeding and breeding habitat of this species have not yet been produced. The extent of suitable habitat for Muir's Corella must be mapped to ensure that the management of those areas is in keeping with the conservation goals for the corellas.

Population survey data will be used to map feeding, roosting and breeding habitat of Muir's Corella. DEC will use these data to map and characterise habitat critical to survival. Strategies will then be developed to maintain existing feeding habitat and nesting trees. This will involve protection of significant woodland remnants, fencing off woodland remnants and ensuring that feeding sites and trees are not cleared prior to the planting of timber trees. In agricultural areas, woodland degradation, lack of eucalypt regeneration and loss of breeding habitat (as a result of changes in land-use) is likely to reduce the number of hollows available to Muir's Corella in the future. Changes in land use will be mapped over time to record the proportion of habitat and potential habitat that has been lost to clearing and land uses, such as agriculture and blue gum woodlots.

The Recovery Team will develop management guidelines, in consultation with stakeholders, for the retention of existing feeding and breeding habitat. These guidelines may be provided to private landholders and tree farming companies via NRM groups in the DEC Warren and Wheatbelt Regions.

Action: Map feeding and breeding habitat critical to survival and all wild and translocated populations, and prepare management guidelines for these habitats

Responsibility: DEC Warren Region, WA Museum, landholders

Completion: Year three

Cost: \$18,000 (\$6,000 per year for three years)

11.5. Revegetate with favoured hollow-bearing trees.

The planting of Marri, Jarrah and Wandoo will be promoted in tree planting programs in liaison with landholders, tree farming companies and NRM groups in the DEC Warren Region. Recommendations will be made for planting to be associated with existing woodland remnants and with plantation establishment. This will be carried out as part of Actions 11.3 and 11.7.

Action: Revegetate with favoured hollow-bearing trees

Responsibility: Recovery Team, DEC Warren Region, landholders, NRM groups

Completion: Ongoing

Cost: Costed as part of Action 11.3

11.6. Determine and implement ways to remove feral Honeybees from nesting hollows.

The availability of nest hollows to Muir's Corella may be increased by removing feral bee hives from hollows (personal communication R. Johnstone¹). Feral Honeybees exclude Muir's Corella from nest hollows by forming long-term hives in key breeding areas (personal communication R. Johnstone¹). A commercial brand insecticide strip, with the active ingredient Dichlorvos (Vapona), that was used to repel feral Honeybees from the nest hollows in Western Australia, is no longer available on the Australian market (personal communication R. Johnstone¹). Thus, research is urgently required to develop and test effective means of killing hives that have established in key breeding areas.

Trials of methods used to kill feral Honeybee hives will be conducted to identify effective methods of removal. The effects of baiting methods or attractants on non-target native species will also be tested. The recovery team will consult with the Western Australian Beekeeper's Association (WABA) and the DEC convened Beekeepers' Consultative Committee to ensure that managed (commercial) Honeybee hives are not affected by control programs on DEC managed land and Crown land.

When the correct dose rates and protocols for the delivery of the insecticide have been established, a program of killing feral Honeybee hives in key breeding areas will be carried out. This program will be monitored and the results will be published in an appropriate scientific journal.

Action: Determine, implement and publish methods of removing Honeybees from nesting hollows

Responsibility: DEC, Water Corporation

Completion date: Year one

Cost: \$44,000

11.7. Produce an information kit to help eliminate illegal killing and distribute to the wider community.

Muir's Corella predominantly occurs on private property and on properties owned or managed by a small number of landholders. While it once fed on native shoots, bulbs and seeds, it now flocks to farmland to feed, where it can damage crops and young trees. The corellas are illegally killed by shooting and poisoning to minimise the damage caused.

Direct communications between the Recovery Team and relevant landholders, commercial tree farmers, and NRM groups in the Warren district is likely to be the most effective means of eliminating illegal killing. An information kit will be prepared, which aims to inform landowners that:

- Muir's Corella is now Endangered and the bird and its habitat are protected by law;
- Shooting to kill and poisoning are illegal and are probably not effective for controlling damage in the long-term;
- There is no easy solution to the damage caused by Muir's Corella, but with planning, co-operation and communication, the damage can be reduced; and
- A knowledge of the biology of Muir's Corella can assist with planning damage control programs.

The information kit will provide information on the most effective means of reducing the damage caused by Muir's Corella. It will be placed on the DEC Naturebase website and distributed by DEC staff to primary producers and local NRM groups (such as the Warren Catchments Council). All reports of illegal killing will be investigated by DEC Wildlife Officers and offenders will be prosecuted where sufficient evidence can be obtained.

Actions: Produce an information kit and distribute in the wider community

Responsibility: DEC

Completion: Year two

Cost: \$3000 (\$1,500 per year for two years)

11.8. Prevent the spread of non-endemic Corella populations in south-west Western Australia.

In south-eastern Australia, the Eastern Long-billed Corella *Cacatua tenuirostris* has become a serious agricultural pest (Emison *et al.* 1994; Bomford and Sinclair 2002). The Eastern Long-billed Corella is known to interbreed with Western Long-billed Corellas in captivity (personal communication R. Johnstone¹) and thus may threaten the genetic integrity of Muir's Corella. Surveys of the numbers of introduced corellas in and around Perth have been conducted by members of Birds Australia since 1998 (Blyth 2004) and will continue. A DEC managed control program for introduced corellas that began in 2003 will also continue.

Extensions in the range of non-endemic corellas in south-west Western Australia will be monitored via annual surveys by Birds Australia WA. In liaison with the Department of Agriculture and Food, DEC will investigate ways in which the spread of introduced corellas can be controlled or prevented. This may include a ban on import of wild-caught corellas into Western Australia, restricting of the import of corellas at State borders and airports and shooting or trapping of birds that become established in south-west Western Australia. A public education program on the pest status of these species and methods that can be used to control them will be prepared by the Department of Agriculture and Food and DEC.

Action: Prevent the spread of non-endemic corellas in south-west Western Australia

Responsibility: DEC, Birds Australia WA, Department of Agriculture and Food

Completion: Ongoing

Cost: \$75,000 (\$15,000 per year over five years)

11.9. Collect DNA samples and analyse to determine the taxonomic status of *Cacatua pastinator* subspecies.

Ford (1987) proposed that two subspecies of the Western Long-billed Corella occur in Western Australia. Muir's Corella *Cacatua pastinator pastinator* has declined and is classified as endangered, while Butler's Corella *Cacatua pastinator butleri* has expanded in range and is common. This is why a genetic study to determine the taxonomic status of the two subspecies is required. Tissue will be collected from Muir's Corella (i.e. the tips of one or two body feathers per individual) as part of the research into the species' breeding biology (Action 11.3). Samples will be collected from 10 to 20 birds from each subspecies, compared and these will also be compared with Little Corellas. Analyses will then be carried out by a geneticist and the results will be communicated to the Recovery Team and the wider community.

Action: Collect tissue samples and analyse to determine the taxonomic status of *Cacatua pastinator* subspecies.

Responsibility: DEC, Museum Victoria

Completion: Year one

Cost: \$6,000

12. SUMMARY OF RECOVERY ACTIONS

Action	Responsibility	Year/Cost (\$)										Total	
		1	2	3	4	5	6	7	8	9	10		
11.1 Seek the funding required to implement future recovery actions.	DEC												In kind, ongoing
11.2 Determine population numbers, distribution and movements.	DEC Warren Region	25,000	25,000	25,000	25,000	25,000	25,000	25,000	25,000	25,000	25,000	25,000	250,000
11.3 Identify factors affecting the number of breeding attempts and breeding success and manage nest hollows to increase recruitment.	WA Museum	5,000	5,000	5,000	5,000								20,000
11.4 Map feeding and breeding habitat critical to survival and all wild and translocated populations, and prepare management guidelines for these habitats.	DEC Warren Region, WA Museum, landholders	6,000	6,000	6,000									18,000
11.5 Revegetate with favoured hollow-bearing trees.	Recovery Team, DEC Warren Region, landholders, NRM groups												Costed in Action 11.3.
11.6 Determine and implement ways to remove feral Honeybees from nesting hollows.	DEC, Water Corporation	44,000											44,000
11.7 Produce an information kit to help eliminate illegal killing and distribute to the wider community.	DEC Warren Region, WA Museum, landholders	1,500	1,500										3,000
11.8 Prevent the spread of non-endemic Corella populations in south-west Western Australia.	DEC, Birds Australia WA, Department of Agriculture and Food	15,000	15,000	15,000			15,000			15,000			75,000
11.9 Collect DNA samples and analyse to determine the taxonomic status of <i>Cacatua pastinator</i> subspecies.	DEC, Museum Victoria	6,000											6,000
Annual Cost		102,500	52,500	51,000	30,000	25,000	40,000	25,000	25,000	40,000	25,000		\$416,000

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