Recovery Plan for the Bush Stone-curlew

Burhinus grallarius

February 2006
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*Burhinus grallarius*

### Executive Summary

This document is the formal New South Wales Recovery Plan for the Bush Stone-curlew *Burhinus grallarius* and, as such, considers the conservation requirements of the species across its known range within New South Wales (NSW). It identifies actions to be taken to enhance the long-term viability of the species in the wild and the parties responsible for carrying out these actions over the next 5 years.

The overall objective of the recovery plan is to secure at least five populations across NSW, with funded management and monitoring programs. To do this we need to learn more about the ecology of the Bush Stone-curlew and the current processes acting to prevent recovery of the species. This recovery plan acknowledges the work and achievements of a large number of people from across NSW who have already invested significant resources into conserving and studying the Bush Stone-curlew. Through the implementation of the recovery plan in NSW it is hoped that community involvement in the conservation of this charismatic species will continue to grow.

The Bush Stone-curlew is listed as Endangered (Schedule 1) on the NSW *Threatened Species Conservation Act 1995*, and has suffered a dramatic decline in abundance across southern and eastern Australia. It was once a common species of open grassy woodlands, occurring widely throughout NSW. The species now occurs in very low densities at scattered locations west of the Great Dividing Range and isolated patches along the northeast and central coast of the state. The main reasons behind the contraction in distribution and abundance of the Bush Stone-curlew appear to be the impact of introduced predators, particularly foxes, dogs and cats, and the conversion of much of the species’ habitat to agricultural pastures or urban landscapes.

In general, low elevation open woodlands with a ground cover of native grasses, fallen timber and leaf litter form the broad habitat requirements of the Bush Stone-curlew. However, in coastal areas the species is also observed foraging within mudflats, saltmarsh and mangroves. It nests and roosts on the ground in areas with sparse, low ground cover and will abandon a nest if disturbed frequently. The species is well camouflaged when in its preferred habitat, and will often lie flat and still on the ground amongst leaf litter and logs if danger is detected. It is easily recognisable, being a large, sedentary bird similar in appearance to a wader.

The Bush Stone-curlew is territorial, particularly during the breeding season, and a pair will often return to the same nest site year after year. Invertebrates form the main component of its diet, and foraging is generally a nocturnal activity. Its distinctive ‘wail’ can often be heard during the evening while it is prodding through the leaf litter and groundcover for food.

It is intended that this recovery plan be implemented over five years, by which time the success of the proposed recovery actions will be able to be assessed and an updated plan prepared. Actions identified in this recovery plan will be principally undertaken or coordinated by the Department of Environment and Conservation (NSW) (DEC), however significant support will be sought from other public and private organisations. Since the release of the draft recovery plan for the Bush Stone-curlew in February 2003, Catchment Management Authorities (CMAs) have been established to manage natural resource issues on a catchment basis across NSW. This plan provides several actions for CMAs and other land managers to undertake in conjunction with DEC.

The DEC welcomes opportunities to work with Catchment Management Authorities, community groups and private corporations that may wish to sponsor the implementation of this plan.

Lisa Corbyn  
Director General

Bob Debus MP  
Minister for the Environment
Acknowledgments

This document was prepared by Catherine Price of the Department of Environment and Conservation (DEC) with advice and input from many experts. It follows a report prepared by David Baker-Gabb, with field work by Glen Johnson and Rick Webster, under contract to the NSW National Parks and Wildlife Service (now DEC). The following DEC officers provided assistance and advice during the preparation of the draft and final recovery plan, and have been involved in the implementation of recovery actions: Craig Arms, Jack Baker, Matthew Cameron, Matthew Chambers, Peter Christie, Phil Craven, Joanne Edney, Peter Ewin, Susan Davis, Pamela Gray, Ron Haering, Alan Henderson, Rob Humphries, Moreno Julli, Dave Kelly, Josh Keating, Colin Killick, Andrew McIntyre, Michael Murphy, Jason Neville, Anthony Overs, Damon Oliver, Liz Phelps, Deyarne Plowman, Todd Soderquist, Eric Schwartz and Graham Wilson. Rachel Lonie (Gosford City Council), Chris Davey (CSIRO), Jose ten Have (CSIRO), Gary Luck (CSU), Elisa Tack (CSU), Andrew Carter (CSU), Ian Davidson, David Parker, Alan Morris, Jody Gates (SA DEH) and Dan Harley (SA DEH) have all assisted generously with technical advice and support for the implementation of actions in the recovery plan.

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The submissions on the draft recovery plan were extremely informative and highlighted several improvements to be made which benefit the final recovery plan, and more importantly the conservation of Bush Stone-curlews in NSW. The time taken to prepare submissions and willingness to participate in the preparation of a recovery plan is much appreciated and sincere thanks is given to all who participated by preparing a submission.
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NSW Recovery Plan

1 Introduction

The Bush Stone-curlew Burhinus grallarius is endangered in NSW, and is one of a number of woodland birds that has declined substantially in abundance and distribution since European settlement. Its decline is linked to the spread of exotic predators, particularly the Red Fox (Vulpes vulpes), and the conversion of large areas of native vegetation to intensive agricultural practices and urban landscapes.

This document constitutes the formal NSW recovery plan for the Bush Stone-curlew and, as such, considers the requirements of the species across its known range in NSW. It identifies the actions to be taken to enhance the long-term viability of the Bush Stone-curlew in nature and the parties which will undertake these actions. Attaining the recovery plan’s objectives will be subject to available funding. It may also be necessary to amend this plan in light of new information. The information in this recovery plan is accurate to July 2005.

2 Legislative context

2.1 Legal Status


2.2 Recovery Plan Preparation

Under the TSC Act (as amended by the Threatened Species Legislation Amendment Act 2004 (TSLA Act)), the Director-General of DEC may prepare recovery plans for all species, populations and ecological communities listed on the TSC Act schedules (other than species presumed extinct). The TSC Act includes specific requirements for both the matters to be addressed by recovery plans and the process for preparing recovery plans. This plan satisfies these provisions.

The TSLA Act established a Threatened Species Priorities Action Statement (PAS) which sets out the recovery and threat abatement strategies for each threatened species, population and ecological community and key threatening process. This recovery plan identifies priority actions which will be used in the PAS.

A draft recovery plan was prepared and publicly exhibited in February 2003. A report on the submissions made regarding the draft recovery plan was prepared for the Minister for the Environment, as required under Section 62 of the TSC Act. The final recovery plan has been amended in response to the public submissions, new information and recent changes to natural resource management in NSW.

2.3 Recovery Plan Implementation

The TSC Act requires that a public authority must take any appropriate measures available to implement actions included in a recovery plan for which they have agreed to be responsible. Public authorities and councils identified as responsible for the implementation of recovery plan actions are required by the TSC Act to report on measures taken to implement those actions. In addition, the Act specifies that public authorities must not make decisions that are inconsistent with the provisions of a recovery plan.

The only public authority responsible for reporting on the implementation of this recovery plan is the DEC. However, other public authorities and organisations have been identified as partners for the implementation of actions where an action overlaps with their area of responsibility or expertise.

It is anticipated that the Catchment Management Authorities will become involved in the implementation of several actions.

The support and involvement of corporate sponsors and community groups in the implementation of this recovery plan is encouraged.

2.4 Relationship to Other Legislation

The land on which the Bush Stone-curlew occurs includes those that are owned or managed by the DEC, Department of Primary Industries (Forests NSW), Department of Lands, Rural Land Protection Boards, local councils and private landholders. Relevant NSW legislation includes:

- National Parks and Wildlife Act 1974 (NPW Act)
- Environmental Planning and Assessment Act 1979 (EP&A Act)
- Local Government Act 1993 (LG Act)
- Threatened Species Conservation Act 1995 (TSC Act)
- Native Vegetation Act 2003 (NV Act)
- Rural Lands Protection Act 1998 (RLP Act)
The interaction of these Acts with the TSC Act is varied and is described below and in Section 2.6 and 2.7.

In NSW, the clearing of native vegetation on private land is subject to either an approved development application or a Property Vegetation Plan (PVP). The PVP is a legal agreement under the Native Vegetation Act 2003 which details the management of native vegetation on a property. It lasts for 15 years and must “maintain or improve environmental outcomes”. A PVP is developed with and approved by the Catchment Management Authority using the PVP Developer (a software program), and provides the basis for financial incentives for landholders and consistent management of native vegetation within CMAs. PVPs should also be consistent with Catchment Action Plans developed by CMAs. The PVP Developer includes a module to assess biodiversity values, including threatened species habitat.

The RLP Act provides for the management of Travelling Stock Reserves (TSRs) by Rural Land Protection Boards (RLPBs), including the conservation of wildlife and the removal of timber. Timber can only be removed from a TSR with the permission of DPI. If the TSR is adjacent to a Nature Reserve or National Park, the Director-General of DEC must be consulted and consideration given to any submissions made by DEC. The RLP Act also gives RLPBs powers to deal with noxious animals, such as foxes. Many TSRs support Bush Stone-curlew habitat. The involvement of RLPBs in the recovery plan is critical given their roles in pest and land management.

2.5 Critical Habitat

The TSC Act makes provision for the identification and declaration of critical habitat for endangered species, populations and ecological communities.

To date, critical habitat has not been declared for the Bush Stone-curlew under the TSC Act. The declaration of critical habitat is not considered to be a priority for the species given its sparse and widespread distribution.

2.6 Environmental Assessment

When exercising a decision-making function under Parts 4 and 5 of the EP&A Act decision-makers must consider known and potential habitat of threatened species, biological and ecological factors and the regional significance of individual populations.

Consent and determining authorities are advised that it would be appropriate to give consideration to relevant recovery plans when exercising a decision-making function under Parts 4 and 5 of the EP&A Act. Therefore, consent and determining authorities should take into account the recovery actions outlined in this plan when considering any activity which may affect Bush Stone-curlews or their habitat. Guidelines for the assessment of impacts on Bush Stone-curlews are to be reviewed as an Action in this recovery plan (Action 6.1; guidelines are provided in Appendix 4 of this plan).

Any other action not requiring approval or development consent under the EP&A Act or meeting other specified exemptions, and which is likely to have a significant impact on the Bush Stone-curlew or its habitat, will require a Section 91 licence from the Director-General of DEC under the provisions of the TSC Act. Such a licence can be issued with or without conditions, or can be refused. A licence is not required:

- To carry out routine agricultural management activities under the TSC Act and NV Act;
- For actions which are carried out in accordance with a consent or approval under the EP&A Act;
- For actions carried out in accordance with a Property Management Plan approved by the Director General of DEC (section 113B of the TSC Act),
- For actions carried out in accordance with an approved Property Vegetation Plan under the NV Act;
- For emergency actions authorised under the Rural Fires Act 1997 or State Emergency and Rescue Management Act 1989.

As part of the Integrated Forestry Operations Approvals (IFOAs) held by DPI (Forests NSW), the DEC has issued licences under the TSC Act for the operation of forestry activities within certain regions. These licences set out minimum measures to protect threatened species and protect their habitat from activities associated with timber harvesting. At the time of writing, IFOAs had been signed for the Lower North East Region, Upper North East Region, Eden Region, and South Coast and Tumut subregions of the Southern Region. IFOAs for the western regions were under negotiation at the time of writing.
Specific measures of relevance to the Bush Stone-curlew in all current IFOAs (except Tumut subregion) include:

- Forestry exclusion zones for 100m radius around a nest site (see Condition 5.13 in Appendix B of IFOAs);
- protection of ground habitat (see Condition 5.17a in Appendix B of IFOAs);
- prohibition of commercial firewood collection within compartments containing records (see Condition 5.17b in Appendix B of IFOAs); and
- implementation of Feral and Introduced Predator Control Plan within 5 years of IFOA (see Condition 5.18b in Appendix B of IFOAs);

Additionally, general pre-logging and pre-roading surveys for threatened species are required as a condition of all IFOAs. Targeted surveys for the Bush Stone-curlew are required in the South Coast subregion of the Southern Region IFOA and the Eden Region IFOA.

The RF Act provides for the Bush Fire Environmental Assessment Code to be prepared which streamlines the environmental approvals required when undertaking hazard reduction activities. Part of the Bush Fire Environmental Assessment Code is the Threatened Species Hazard Reduction List. This List describes conditions on the use of fire and other mechanical forms of hazard reduction activities to minimise adverse impacts on threatened species, including the Bush Stone-curlew.

2.7  Relevant Authorities

The following public authorities and organisations are currently known to have a function of relevance to the conservation of the Bush Stone-curlew:

- the DEC, where a concurrence role under the EP&A Act is required,
- the DEC, where a Section 91 licence (under the TSC Act) is required,
- the DEC, for decisions under Part 5 of the EP&A Act,
- the DEC, for granting biodiversity certification to environmental planning instruments under Schedule 1 TSLA Act (section 126G),
- the DEC, for granting biodiversity certification to the native reform package under Schedule 1 TSLA Act (section 126C),
- the DEC, as a land manager (see Appendix 1);
- The Department of Lands in relation to Crown Land, subject to the provisions of the Crown Lands Act 1989,
- 13 Catchment Management Authorities in relation to the preparation of Catchment Action Plans and Investment Strategies (see Appendix 1),
- 13 Catchment Management Authorities in relation to developing and approving both offset and incentive Property Vegetation Plans (see Appendix 1),
- The Natural Resources Commission in relation to the setting of state-wide standards and targets for natural resource management and recommending the approval of Catchment Action Plans,
- DIPNR as a consent authority in relation to the Unincorporated Area of western NSW,
- DIPNR as a consent authority for major development and infrastructure projects under the Environmental Planning and Assessment Amendment (Infrastructure and other Planning Reform) Act 2005,
- Department of Primary Industries (DPI) (Forests NSW) as a land manager (see Appendix 1);
- DPI (Agriculture) in relation to advice provided and research undertaken regarding pest and weed management,
- Rural Lands Protection Boards in relation to pest control activities,
- Rural Lands Protection Boards in relation to the management of Travelling Stock Routes,
- Approximately 93 local councils (see Appendix 1),
- Australian Plague Locust Commission in relation to control of plague locusts and the mitigation of impacts to wildlife,
- Commonwealth Department of Defence, as a land manager.

3  Species Information

3.1  Conservation Status

The total Australian population of Bush Stone-curlews is estimated as approximately 15,000, with the vast majority of birds occurring in northern Australia (Garnett and Crowley 2000).
No reliable population estimate for New South Wales has been made, however based on current records in the Atlas of NSW Wildlife it is probably around 1000 breeding pairs and declining. Although direct comparisons cannot be made, records in the first Australian Bird Atlas from 1977-1981 (Blakers et al 1984) and the second Australian Bird Atlas from 1998-2001 (Barrett et al 2003) suggest that Bush Stone-curlews have declined in abundance in NSW over this time (Price 2004, Davey 2005). The total Victorian population is estimated to be between 500 and 1000 breeding pairs (Robinson and Johnson 1997).

The Royal Australasian Ornithologists Union has listed the Bush Stone-curlew as a species of special concern (Garnett 1992). The Action Plan for Australian Birds listed the species as ‘Near Threatened: c’, with the extent of occurrence, area of occupancy and number of breeding birds all in decline (Garnett and Crowley 2000). The ‘Near Threatened’ category is used for taxa which are close to qualifying for ‘Vulnerable’. The ‘c’ is allocated to species which have experienced a significant and continuing decline in abundance in over 50% of their former area of occupancy and/or extent of occurrence (Garnett and Crowley 2000).

The Bush Stone-curlew is not currently listed as threatened on the Commonwealth Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act).

The Bush Stone-curlew has declined markedly in New South Wales, Victoria and South Australia (with the possible exception of Kangaroo Island) over the last century (Marchant and Higgins 1993; Johnson and Baker-Gabb 1994; Robinson 1994; Blakers et al 1984; Davey 2005, Gates and Paton 2005). In NSW, the Bush Stone-curlew is listed as endangered under the TSC Act, in Victoria it is listed as threatened under the Flora and Fauna Guarantee Act 1988, and in South Australia it is listed as vulnerable under the National Parks and Wildlife Act 1972. The IUCN Red List has the Bush Stone-curlew categorised as LR/nt (Lower Risk/near threatened) (Hilton-Taylor 2000).

The long-term viability of populations in northern Australia has not been assessed. Magnetic Island, Queensland, supports a significant population of Bush Stone-curlews (approximately 600-700 birds) (Andrews 1997). However, as the majority of the species’ habitat is earmarked for urban development the long-term future of the population should not be regarded as secure (P. Centurino QPWS pers. comm.).

3.2 Description

The Bush Stone-curlew is an easily identifiable bird given its size (beak to tail length 55-59cm), and appearance (Pizzey and Knight 2003). It stands between 50 and 60cm tall with long legs and a mottled brown, white and grey plumage. The weight of adults varies (recorded weights range from 530g to 1247g), with males generally heavier than females (Gates 2001; Marchant and Higgins 1993). Evidence from recent field studies indicates that birds in southern NSW may be heavier than those in the north (E. Tack CSU pers. comm.).

The Bush Stone-curlew has a large, yellow eye, a short, dark bill and a hunched appearance when walking (Marchant and Higgins 1993). In flight, the Bush Stone-curlew reveals a broad pale panel across the centre of the wing and a flash of white near the wing tips (Marchant & Higgins 1993). It flies with the neck stretched forward and legs trailing beyond the tail tip.

The Bush Stone-curlew exhibits some variation in feather colour across its range, with a rufous and a grey morph described (Marchant and Higgins 1993). The rufous morph occurs only in northern Australia, and is most prominent in arid areas (Marchant and Higgins 1993). It intergrades with the grey morph along the eastern and western coasts of Australia.

The Bush Stone-curlew is nocturnal and tends to lie or stand motionless in woodlands during the day. Its presence is most often indicated by its distinctive whistling and wailing ‘weer-lo’ calls after dark.

The Bush Stone-curlew is known by a variety of other common names, such as Bush Thick-knee (due to the characteristically large tibiotarsal joint of the leg), Southern Stone-curlew (Boehm 1960), Southern Stone-plover, Weeloo and Willaroo (Pizzey and Knight 2003).

Although a member of the shorebird order, it is generally known as a bird of open woodlands (Pizzey and Knight 2003).

3.3 Taxonomy

The Bush Stone-curlew, with the other stone-curlews or ‘thick-knees’, is a member of the family Burhinidae and the shorebird order Charadriiformes (Marchant and Higgins 1993). This Burhinidae family consists of medium to large terrestrial or littoral birds that are found on all continents except North America and Antarctica (Marchant and Higgins 1993). Currently, the family consists of nine species in two genera – Burhinus and Esacus (Marchant and Higgins 1993). Burhinus grallarius,
the Bush stone-curlew and *Esacus magnirostris*, the Beach stone-curlew are the only species from the family in Australia (Marchant and Higgins 1993) and both are endangered in NSW.

No subspecies of the Bush Stone-curlew are currently recognised (Marchant and Higgins 1993; Pizzey and Knight 2003). However, three subspecies/races of the bush stone-curlew have been previously described: *magnirostris* of southern Australia; *rufescens* of northwestern Australia and the Northern Territory; and *ramsayi* of north Queensland (Lane 1987). Unpublished data based on morphological variation indicates that subspecies may occur (Mason and Schodde 2004), but it is unclear whether there is geographic separation between the putative subspecies.

Genetic analysis to assess if there is genetic differentiation between individuals from different parts of the species range was commenced by CSIRO, but has ceased prior to completion. An action is proposed to investigate genetic variation within the species (Action 7.3).

### 3.4 Distribution

#### 3.4.1 Australia

The Bush Stone-curlew has a broad distribution, having been recorded from almost all but the most arid areas of mainland Australia and on many offshore islands (Garnett & Crowley 2000; Barrett *et al.* 2003). It occurs across northern and southwestern Western Australia, the Northern Territory, Queensland, throughout coastal and inland New South Wales, central and northwestern Victoria, southeastern South Australia and southern coastal Papua New Guinea (Garnett and Crowley 2000; Marchant and Higgins 1993). However, it has suffered severe declines in abundance throughout its range in southern, eastern and western Australia which appear to correlate with the distribution of the fox (Robinson 1998) and extent of habitat modification (Marchant & Higgins 1993). It is now rare to absent south and east of the Great Dividing Range between Brisbane, Queensland and Port Fairy, Victoria (Garnett & Crowley 2000). It is still reasonably common on Kangaroo Island, South Australia, which is free of foxes (Gates and Paton 2005).

#### 3.4.2 NSW

Historically, the Bush Stone-curlew was widespread and reasonably common in NSW from the Queensland to the Victorian border east and west of the Great Dividing Range in grassy woodlands (Marchant & Higgins 1993, Hindwood and Hoskin 1954). It remains widely distributed in NSW but in very low densities, and is now locally extinct from many areas of its former range (McGill 1944, Hindwood and Hoskin 1954, Heron 1973, Baldwin 1975, Schmidt 1978, Smith *et al.* 1995, Blakers *et al.* 1984, Marchant & Higgins 1993, Barrett *et al.* 2003, Davey 2005, Atlas of NSW Wildlife). In general, Bush Stone-curlews are not found on the escarpments but in lower elevation grassy woodlands of the coast or west of the divide throughout the sheep-wheat belt.

Inland of the Great Dividing Range the Bush Stone-curlew occurs to about the 300mm rainfall isohyet, and then becomes more scarce and associated with riverine woodlands (Robinson 1994).

The current NSW distribution is patchy and scattered. Current records suggest that all Catchment Management Areas in NSW support Bush Stone-curlews but there is limited knowledge of local distribution and abundance for most areas. Figure 1 illustrates the current records on the Atlas of NSW Wildlife.

The area bounded roughly by Albury, Wagga Wagga, Hay and Wentworth is regarded as the stronghold for the species in NSW (Barrett *et al.* 2003, Atlas of NSW Wildlife), with small and scattered populations occurring throughout the central west of the state, for example around Forbes-Caragabal, Gulargambone-Collic, Mungindi (Atlas of NSW Wildlife, Davey 2005).

In western NSW, the following areas support small numbers of Bush Stone-curlews:

- the River Red Gum *Eucalyptus camaldulensis* and Black Box *E. largiflorens* woodlands adjoining Boree *Acacia pendula* country;
- Conargo – Deniliquin – Barham – Wakool – Oaklands;
- the River Red Gum *E. camaldulensis* and Boree *A. pendula* country along the Murrumbidgee River around Darlington Point;
- the Travelling Stock Routes and grassy woodlands of the Warren – Gilgandra – Coonamble – Gulargambone – Baradine area;
- the remaining grassy woodlands of Moree, Mungindi and Cubberoo;
- Bimble Box woodland and very open Coolibah woodland between Walgett and Collarenebri (T. Mazzer DIPNR pers. comm.);
- Poplar Box–Wilga woodland and Baradine Gum-White Cypress woodland in the central west of NSW (Shelly 2001);
• along the Bogan River and Narran River (Shelly 2001);
• river flat areas, Belah woodland and Belah-Rosewood-mallee vegetation around Buronga and Mildura (J. Val DIPNR pers. comm., 3/02/04; Shelly 2001); and
• mixed Coolibah – Poplar Box – cypress vegetation (i.e. Lightning Ridge Woodlands).

Coastal populations occur sporadically from Sydney to the Queensland border, with fewer records south of Sydney. Coastal areas known to support small populations include:

- Pittwater - Brisbane Waters area;
- Port Stephens - Pindimar;
- Valla - Coffs Harbour;
- Grafton – Yamba; and
- Murwillumbah – Pottsville - Koala Beach.

South of Sydney, Bush Stone-curlews have been reported around Nowra, Narooma and Bermagui. Bush Stone-curlews also occur west of Maitland and in the vicinity of Karuah (M Chambers NPWS pers. comm.).

Throughout the state, comprehensive field surveys within areas of suitable habitat are required to gain a better understanding of the current distribution and abundance of the Bush Stone-curlew.

Figure 1 illustrates the current Bush Stone-curlew records held in the Atlas of NSW Wildlife.

Appendix 1 lists the administrative areas within which records of the Bush Stone-curlew occur, including local government areas (LGAs), Catchment Management Areas (CMAs), Rural Lands Protection Boards (RLPBs) and DEC Areas. A list of conservation reserves and State Forests which contain records within or close to a boundary has also been compiled from the Atlas of NSW Wildlife (Appendix 1).

3.5 Biology and Ecology

3.5.1 Behaviour

Bush Stone-curlews are regarded as nocturnal and are generally active from dusk to dawn. On moonlit nights, birds appear to be more active (Johnson and Baker-Gabb 1994). During the day, Bush Stone-curlews are most commonly observed singly or in pairs roosting within or close to the edge of woodland remnants amongst fallen timber or ground litter (Johnson and Baker-Gabb 1994). Individuals and pairs generally exhibit high site fidelity.

If disturbed, different birds exhibit different behaviours, but it is commonly observed that they run or quickly walk from a disturbance, stopping at intervals and bobbing their head up and down. Alternatively, birds will lie flat on the ground with their head and neck outstretched and are usually well camouflaged (Marchant and Higgins 1993, Johnson and Baker-Gabb 1994). If approached quickly, many birds will take flight. If a particular roost or nest site is frequently disturbed or the habitat is altered, it may be abandoned altogether (Johnson and Baker-Gabb 1994).

Birds within a population may gather together at night to feed communally and display to one another (Marchant and Higgins 1993). Large groups used to be reported in southern Australia and still occur in northern Australia (Johnson and Baker-Gabb 1994, Davey 2005).

3.5.2 Breeding and Biology

Bush Stone-curlews live for approximately 30 years (McGilp 1947) and are believed to hold long-term pair-bonds (Flavell 1992). Breeding probably begins at 2-3 years of age (Marchant and Higgins 1993), although birds in captivity may begin earlier (Mrs J. Lubke pers. comm.).

The Bush Stone-curlew breeding season begins with a noisy courtship around August-September in NSW and has generally finished by March (Marchant and Higgins 1993, Price 2004). Nesting appears to begin later further south (Johnson and Baker-Gabb 1994, Jan Lubke pers. comm.). To signal they are preparing for breeding, Bush Stone-curlews begin calling more frequently and breeding pairs will be regularly observed at nest sites, where they remain until a clutch is laid. A breeding pair will have between one and three clutches within a breeding season (most frequently one or two), with each clutch usually containing two eggs (Andrews 1997, Johnson and Baker-Gabb 1993).

Eggs are laid directly on bare ground, with grass and leaves scraped away (Johnson and Baker-Gabb 1994). The nest site is typically in or near the edge of open grassy woodland or within a cleared paddock where there is good visibility across the surrounding lands (Johnson and Baker-Gabb 1994). Nest sites can be near or beside a fallen log or exposed tree root, and this may provide some camouflage for nesting birds (C. Price DEC pers. obs). However, this is not always the case. Nest sites are sometimes abandoned if the grass around the nest becomes taller than about 15cm (Johnson and Baker-Gabb 1994). The same nesting areas may be used in successive years and some have been reported to have been used for almost 30 years.
The incubation period is between 22 and 30 days, with both parents participating in the incubation and care of the young (Andrews 1997). The chicks are nidifugous, leaving the nest site within an hour or two of hatching, and often remain with the parents until the next breeding attempt. The length of time that the young remain with the parents can vary from three to nine months depending on whether they are from the first or second brood of the season (Bedggood 1977, Marchant & Higgins 1993). The young from the first clutch is chased away from the nesting area by the parents 1 to 2 weeks before the second clutch is laid (Marchant & Higgins 1993). Both parents feed the chick until it is approximately 4 weeks of age (Andrews 1997) and it is usually approximately 8 to 10 weeks before a chick can fly (Price 2004). The chick is extremely vulnerable to predation during this time and instinctively lies flat to the ground in an attempt to remain camouflaged if it senses danger. The adults vigorously defend their young, and their territory, from intruders and potential predators during the breeding season.

A study in Victoria found that about half of breeding pairs manage to raise one young to independence each year (Johnson & Baker-Gabb 1994). While this level of breeding success might seem adequate, there is no data on recruitment of juveniles into the adult breeding population.

### 3.5.3 Diet

Bush Stone-curlews have a generalist diet, foraging on a wide variety of flying and ground-dwelling invertebrates (including locusts and grasshoppers), seeds, small fruit, crustaceans, molluscs, frogs, lizards, snakes and even mice (Marchant & Higgins 1993, Barker and Vestjens 1989).

Foraging can occur over a wide area, including irrigated paddocks, grasslands, woodlands, domestic gardens, saltmarsh, mangroves, and playing fields. Birds adopt a heron-like stalking posture when foraging and stab quickly at the ground to catch their prey in soft soil and mud, amongst fallen timber, rotting wood, pebbles and debris (Marchant and Higgins 1993).

### 3.5.4 Population dynamics and home range characteristics

Information on home range characteristics of Bush Stone-curlews comes mainly from observational studies and anecdotal evidence. Only one radio-tracking study has been undertaken to date, on Kangaroo Island, South Australia where Bush Stone-curlews are more abundant than in NSW (Gates 2001) and banding studies have only recently commenced (Price 2004, Dan Harley SA DEH pers. comm., Elisa Tack CSU pers. comm.).

Home range characteristics have not yet been studied in NSW. Home range sizes are likely to vary depending on the availability and proximity of roosting, foraging and breeding habitat. Banding of individuals and radio-tracking studies are required to increase our knowledge of home range characteristics in NSW, and are supported by this recovery plan.

On Kangaroo Island, Bush Stone-curlews fell into 4 groups with different home range and movement characteristics – 1) resident breeding birds, 2) mobile breeding birds, 3) non-breeding birds or 4) resident first year juveniles (Gates 2001).

Resident breeding birds remained with their partner and in their home range year round, and had home ranges of 26-64 hectares (Gates 2001). Pairs exhibiting similar behaviour have been observed at several sites in NSW, for example at Lemon Tree Passage and in Kincumber on the Central Coast (Price 2004). Such high site fidelity suggests these areas provide optimal habitat (Gates 2001).

Consistent use of roost and nest sites by Bush Stone-curlews has also been observed across NSW, Victoria and mainland South Australia (Bedggood 1977, Johnson and Baker-Gabb 1994; Marchant and Higgins 1993, Price 2004, Dan Harley SA DEH pers. comm.).

Mobile breeding Bush Stone-curlews exhibited different behaviour to resident breeding birds during the non-breeding season (Gates 2001). During this time, this group flew long foraging distances, used communal roost sites and had large home ranges of up to 337 hectares (Gates 2001). During the breeding season, their home range contracted to approximately 39 hectares (Gates 2001). It has been suggested that these birds could be first time breeders searching for a suitable breeding territory or that young birds breeding for the first time may not immediately establish year-round territories or that suitable habitat was limited.

A study in northern Victoria estimated breeding territories to be in the order of 10-25 hectares, with
the family remaining in this area for 1 to 8 weeks or while there are dependent young (Johnson and Baker-Gabb 1994).

A first year juvenile remained with the parents until the following breeding season (Gates 2001). Similar behaviour was observed in a first year juvenile on the Central Coast of NSW (Price 2004).

Non-breeding Bush Stone-curlews on Kangaroo Island had larger, loosely defined home ranges, were observed roosting communally and were associated with a group of birds (Gates 2001). Erratic movements of up to 8km were recorded, which could indicate these were dispersing individuals, and foraging distances were typically over 2km (Gates 2001). Groups of non-breeding Bush Stone-curlews have also been observed on Magnetic Island, Queensland (Andrews 1997). It has been suggested that this may be related to a lack of suitable nesting habitat and/or foraging resources (Andrews 1997).

In northern Victoria it was estimated that a pair of Bush Stone-curlews may have day roost sites across an area up to 250 hectares, but up to 600 hectares could be used for nocturnal foraging (Johnson and Baker-Gabb 1994).

3.6 Habitat Requirements

In NSW, Bush Stone-curlews occur in lowland grassy woodland and open forest, much of which has been cleared for agriculture and urban development (Johnson and Baker-Gabb 1994, Keith 2004). Most studies of the species have been in modified environments where native vegetation exists in small, isolated remnants and introduced predators are present (eg Johnson and Baker-Gabb 1994, Davey 2005, Price 2004). Therefore, current habitat characteristics of the species may not reflect pre-European habitat characteristics but rather an adaptation for survival in disturbed and modified environments (C. Davey pers. comm.).

Bush Stone-curlew habitat is described by broad ground and understorey structural features and is not necessarily associated with any particular vegetation communities. In general, habitat occurs in open woodlands with few, if any, shrubs, and short, sparse grasses of less than 15cm in height, with scattered fallen timber, leaf litter and bare ground present. In coastal areas, structurally similar elements of tidal and estuarine communities provide suitable habitat, for example Bush Stone-curlews are recorded within Casuarina woodlands, saltmarsh and mangroves (Price 2004).

The important structural elements of Bush Stone-curlew habitat appear to be:

- a low sparse ground cover
- some fallen timber and leaf litter
- a general lack of a shrubby understory
- open woodlands.

Bush Stone-curlews appear to be associated with lower elevations in fairly flat or rolling country (Johnson and Baker-Gabb 1994). A study of 167 sites in northern Victoria found that virtually all sites were below 300m elevation, and that 59% were below 150m (Johnson and Baker-Gabb 1994).

In estuarine areas, Bush Stone-curlews have been recorded in Swamp Oak *Casuarina glauca* groves, saltmarsh, mangroves and Paperbark *Melaleuca quinquenervia* woodlands (Morris 2002).

West of the Great Dividing Range, Bush Stone-curlews are recorded in lowland grassy woodland and open forest remnants. Vegetation communities include Grey Box *E. microcarpa*, River Red Gum *E. camaldulensis*, Black Box *E. largiflorens* and Yellow Box *E. melliodora*, with a ground cover of low, sparse native grasses and few or no shrubs, although wattles *Acacia* spp. are occasionally present (Marchant & Higgins 1993, Johnson & Baker-Gabb 1994). Bush Stone-curlews also occasionally occur in box-ironbark forests and patches of she-oaks (*Allocasuarina* spp.). Wallaby grasses *Austrodanthonia* spp. are often present in the ground cover at sites with Bush Stone-curlews, and introduced Barley Grass *Hordeum leporinum* in some more disturbed sites (Johnson & Baker-Gabb 1994). Several other species of grasses from the genera *Austrostipa*, *Poa*, *Agropyron* and *Bromus* are often recorded at roost sites (Johnson & Baker-Gabb 1994). Species such as Common Onion Grass *Romulea rosea* and clovers *Trifolium* spp. are infrequently recorded at roost and nest sites over summer when the birds are breeding, but are abundant and dominant after autumn rains (Johnson & Baker-Gabb 1994).

Specific habitat requirements for nesting, foraging and roosting appear to be different and the proximity of suitable areas for each activity is likely to influence abundance and distribution of Bush Stone-curlews (Gates 2001, I. Davidson pers. comm.). The presence and abundance of predators or other disturbances reduces the suitability of habitat for particular activities, especially nesting.

Nesting sites are frequently located in relatively open areas, where ground cover is extremely low and/or sparse (less than 15cm). It is likely that visibility across the surrounding area is important as it may reduce the vulnerability of nesting birds to approaching predators. Nests are frequently recorded in areas lacking in native vegetation, such as mown lawns, ploughed paddocks and paddocks cut for hay, dirt and gravel roads, seaweed on sand beach, playing fields, vacant lots. However, nests have also been recorded within patches of remnant
woodland, and nests in these areas may be less frequently recorded as they are more difficult to find. Distance to and availability of adequate foraging resources may also influence nest site selection (Andrews 1997, Price 2004).

A study of habitat attributes around the Caragabal-Grenfell area of Central Western NSW indicated that open sites were preferred by Bush Stone-curlews during the breeding season, with a high proportion of bare ground and good ground-level visibility the main indicators of habitat (Davey 2005). This study was undertaken in areas of Bulloak Allocasuarina luehmannii, Myall Acacia pendula, Box eucalypts and White Cypress Pine Callitris glaucophylla.

In northern Victoria, nest sites were an average distance of 12.7m from the nearest tree, and 3.9m from fallen timber (Johnson and Baker-Gabb 1994).

By day, birds roost on the ground amongst fallen tree debris where their mottled plumage provides excellent camouflage and the open terrain provides good visibility (Marchant & Higgins 1993). These daytime roosts are typically found in woodland patches that are less than 1km from other patches of similar habitat and less than 250m from water (Johnson & Baker-Gabb 1994).

Day roosts are generally under large trees or within woodland remnants with fallen timber and leaf litter on the ground, and short, sparse grass or bare ground. Bush Stone-curlews have been observed roosting under she-oaks in coastal areas, and are well camouflaged amongst the fallen needles (Price 2004).

Areas with stands of remnant vegetation or plantation woodlots of 1-5 hectares with large trees and little or no understorey shrubs are most commonly used as roost areas (Johnson and Baker-Gabb 1994). Roost sites have generally not undergone pasture improvement, modification by irrigation, artificial fertilizer or cultivation (Johnson and Baker-Gabb 1994).

The presence of fallen tree debris appears critical to the selection of day roost sites, with a study of 95 roost sites in Victoria finding 98% of sites had more than 10% tree debris cover and 42% had more than 50% cover (Johnson & Baker-Gabb 1994). By contrast, 65% of non-roost sites in the surrounding environment had less than 2% tree debris cover and 96% had less than 30% cover (Johnson & Baker-Gabb 1994). The other critical difference between day roost sites and non-roost sites was the height and composition of the grass cover. For roost sites, grass height was less than 15 cm at 67% of sites and was dominated by native grasses at 68% of sites. The grass height was more than 15 cm at 92% of comparison non-roost sites and consisted of sown pasture at 70% of non-roost sites. Bush Stone-curlews were rarely recorded roosting at sites with sown pasture (Johnson & Baker-Gabb 1994).

At night, Bush Stone-curlews travel as far as 3km from the roost site to feeding grounds (NPWS 2000). Bush Stone-curlews will nocturnally forage in a variety of areas, including irrigated and pasture-improved paddocks, playing fields, waste disposal facilities, mangroves, saltmarsh, mudflats, swamps and woodland remnants as these areas are likely to support an abundance of insects and other food resources.

Availability of safe and suitable breeding habitat is likely to be the limiting factor for most Bush Stone-curlew populations, followed by roosting habitat and then foraging habitat (Price 2004).

3.7 Land Tenure

Given the lack of survey effort across most of NSW, it is difficult to estimate the proportion of Bush Stone-curlews occurring on public or private lands.

An analysis in 2003 found that of the 183 records of the Bush Stone-curlew in the Atlas of NSW Wildlife, approximately 14% are in formal conservation reserves (ie National Parks and Nature Reserves), and an additional 6% are in State Forests (NPWS 2003). The majority of the remaining records are on private land or public land which is not managed primarily for conservation. Similarly, in a study of 167 Bush Stone-curlew sites in northern Victoria, 83% were on private land (Johnson & Baker-Gabb 1994).

The sympathetic management of suitable habitat on public land is extremely important for the recovery of the Bush Stone-curlew in NSW and Victoria (Robinson and Johnson 1997). Large areas with restricted public access, such as land owned by the Department of Defence, can support significant Bush Stone-curlew populations, for example Puckapunyal Army Reserve (Johnson and Baker-Gabb 1993). Bush Stone-curlews have been recorded on Department of Defence reserves in NSW (Atlas of NSW Wildlife 2005) and these areas warrant further investigation of their potential to support Bush Stone-curlew populations.
4 Ability of Species to Recover

Evidence from captive populations and the situation in northern Australia and Kangaroo Island, South Australia, suggest that the Bush Stone-curlew is capable of increasing in numbers if predation by introduced predators is reduced and suitable habitat is available.

On Kangaroo Island in South Australia, which is fox-free, the Bush Stone-curlew is widespread and common, and exhibits a preference for agricultural areas supporting fragmented native vegetation (Gates and Paton 2005).

Anecdotal evidence suggests that if nests sites and chicks are protected from predators (eg enclosed by predator-proof fencing), breeding success may be enhanced and recruitment may increase, provided that suitable foraging and roosting habitat is available in the vicinity of the nest site.

Another factor affecting the ability of the species to recover is the aging of the wild Bush Stone-curlew population given that juvenile recruitment appears to be low. It is a concern that the persistence of long-lived adult birds may be masking poor recruitment into the population, and a sudden population crash may occur if a high percentage of the older birds die within a few years (NPWS 2000). Anecdotal reports suggest this may have already occurred in some areas, such as Hume and Culcairn Shires (Mr N. L. Lubke pers. comm.).

As well as focussing on increasing breeding success, the amount and quality of habitat will need to be increased if dispersing young birds are going to survive. Ongoing management of habitat is required to ensure that critical habitat features are present, such as short, sparse groundcover during the breeding season, fallen timber and protection from predators. Left unmanaged, large areas of potential habitat can become unsuitable if invaded by weeds, inappropriate grasses or predators.

Coastal populations are under pressure from increasing coastal development compounded by high land values (Price 2004). Priority management and protection of suitable habitat is required for populations to survive in the long-term, in addition to increasing habitat where possible.

Bush Stone-curlews will only be conserved if their current threats are abated and suitable habitat remains intact.

5 Management Considerations

5.1 Introduced species

As mentioned previously, the introduced Red Fox *Vulpes vulpes* preys on adult and young Bush Stone-curlews and is thought to be a major cause of its decline on the mainland (Gates 2001). Several other introduced species may also prey on the species. As well as foxes, feral and domestic cats and dogs will prey on adult birds and chicks. Foxes, dogs, feral pigs and rats may eat eggs and chicks, with feral pigs also likely to trample on nests. Indirectly, the presence of rabbits may increase the density or abundance of foxes in an area and increase the risk to Bush Stone-curlews however they may also keep grass levels low and positively impact on habitat availability.

The NSW Fox Threat Abatement Plan (Fox TAP) ranks the Bush Stone-curlew highly as a species which suffers population level impacts from fox predation (NPWS 2001). However, given the widespread and isolated distribution of Bush Stone-curlews, no Fox TAP programs specifically target Bush Stone-curlew populations at present.

The impact of foxes on Bush Stone-curlew mortality has not been measured experimentally, but anecdotal evidence demonstrated that foxes can kill adult Bush Stone-curlews as well as chicks. The observations of landholders suggest that nesting success and juvenile survivorship increases when predators are excluded or removed from breeding habitat (Johnson & Baker-Gabb 1994; Mr N. J. Lubke pers. comm.).

Given the relationships between fox and rabbit numbers, and fox and cat impacts, integrated programs that seek to control several introduced species, rather than programs which focus on a single introduced species, are recommended.

5.2 Habitat

The other major cause of decline of Bush Stone-curlews has been extensive clearing and modification of its preferred lowland woodland habitat for agriculture and urban development. Recovery of native vegetation is not possible in some areas due to present land-use regimes (eg urban or intensive agriculture). Sympathetic management of existing habitat on private and public lands is crucial for the long-term survival of the species.

A better understanding of micro and macro-habitat features required for foraging, nesting and roosting is required for developing habitat management guidelines. The specific habitat requirements of
Bush Stone-curlews remain unclear, although studies and anecdotal evidence suggests that a mix of cleared land and remnant vegetation is sufficient to support large populations of Bush Stone-curlews (Gates and Paton 2005, Andrews 1997).

5.3 Removal of fallen timber

Removal of fallen timber leaves woodland unsuitable for Bush Stone-curlews, which forage amongst fallen timber and rely on it for camouflage when roosting. Removal of fallen timber and debris is likely to have contributed to a decline in available suitable habitat for the Bush Stone-curlew in NSW.

Fallen timber is often collected for firewood or burnt to get a clear area for cropping or pasture improvement.

Landholders may be hesitant to retain fallen timber as it is thought to provide a refuge to introduced species, such as rabbits and foxes. The management of both species is required to reduce an array of ecological and agricultural impacts (see Section 5.1).

A better understanding of the role of fallen timber in providing habitat for the Bush Stone-curlew is required. Anecdotal evidence suggests that retaining or adding fallen timber to an area increases its use by Bush Stone-curlews and that chicks will hide under fallen branches if threatened (C. Price DEC pers. obs.). Relocating fallen timber to a nearby area, rather than burning it, is recommended.

5.4 Degradation of Remnant Vegetation

Many areas supporting remnant native vegetation are being, or have been, degraded by current or historical land management practices. Land-use practices which are inappropriate in close proximity to actual or potential habitat of Bush Stone-curlews include the application of fertilizers, insecticides and pesticides, intensive cropping and the incremental clearing of trees. The impacts of past and present land management practices include loss of native vegetation, increasing salinity, weed invasion and lack of tree regeneration, and all have substantial negative impacts on actual or potential Bush Stone-curlew habitat. Most of these activities tend to increase the height and density of grasses, decrease foraging resources or remove camouflage for sheltering birds (Johnson & Baker-Gabb 1994, Webster & Baker-Gabb 1994).

In semi-urban and urban areas, areas of remnant vegetation are degraded by weed infestations, rubbish dumping, vandalism, high levels of human visitation, inappropriate fire regimes or hazard reduction activities, uncontrolled domestic animals, introduced animals, noise, alteration to drainage patterns and increased nutrient runoff. The potential for remnant native vegetation to support Bush Stone-curlews is reduced by these factors.

5.5 Grazing

Grazing can have both positive and negative effects on Bush Stone-curlew habitat depending on the condition of the area and its disturbance history. At roost sites or nest sites where grasses grow tall and thick, grazing will benefit Bush Stone-curlews by maintaining visibility near ground level for sitting birds (Johnson & Baker-Gabb 1994). Intensive pulse grazing has been used to reduce grass height within Bush Stone-curlew habitat prior to the breeding season with success (Mr Neville Lubke pers. comm.). But high density stocking rates may cause birds to leave their previously preferred roost or nest area and should be avoided around nest sites during the breeding season.

Grazing animals have trampled eggs when birds have nested within paddocks (Price 2004). The use of temporary electric fencing to keep stock away from nests and protect eggs has been used successfully in the Riverina and on the Central Coast (L. Wheaton pers. comm., Price 2004).

Persistent grazing may diminish the quality of Bush Stone-curlew habitat by decreasing the amount of litter and the abundance of litter-dwelling invertebrate foods (King & Hutchinson 1983, Scougall et al. 1993). Overgrazing also encourages the invasion of woodland remnants by exotic grasses and increases the need for future management of grass growth by grazing (Robinson & Johnson 1997).

5.6 Land use intensity

Increases in the intensity of land use close to daytime roosts or nesting areas are generally detrimental to Bush Stone-curlews. Any activity which provide opportunities for predators to increase in abundance or reduces Bush Stone-curlew habitat will cause declines in Bush Stone-curlew populations over time. In northern Victoria, Webster and Baker-Gabb (1994) recorded a 42% decrease in the abundance of Bush Stone-curlews at 72 sites in just six years. No single cause for this significant decline could be identified and it appeared to be the result of incremental changes to
farming practices over the time period. Activities such as clearing of vegetation, cultivation, irrigation, pasture improvement, removal of tree debris, chemical use, altered stocking rates, and subdivision of rural land occurred in areas initially supporting Bush Stone-curlews, and may be implicated in the overall decline in abundance of the species. Long-term conservation of Bush Stone-curlews seems to require the maintenance of low-intensity land use around known sites and minimal human disturbance of nest sites (Johnson and Baker-Gabb 1994).

5.7 Fire

Whilst fire is a natural element of the Bush Stone-curlew’s environment, inappropriate fire regimes over time and/or a single fire event have the potential to reduce the suitability of habitat for the species and/or kill individual birds, particularly chicks. Inappropriate hazard reduction activities can also adversely impact upon Bush Stone-curlew habitat. The loss of individual birds can be significant when a small, isolated population is declining and breeding success is low. This is likely to be the case in many areas that currently support Bush Stone-curlews in NSW.

It has been suggested that numerous fires over 50 years played a role in the extinction of a population from Wilson’s Promontory, Victoria (Cooper 1975).

Weed invasions, particularly exotic pasture grasses and understorey species, often occur following fire if preventative management measures are not taken. These species are often dense and tall, rendering areas unsuitable for the Bush Stone-curlew. Woody debris and leaf litter used by the Bush Stone-curlew for foraging and camouflage is burnt in fires and can take time to build up to a suitable level.

5.8 Insecticide and chemical use

There is emerging evidence that the use of certain insecticides and chemicals may have contributed to the decline in Bush Stone-curlew populations either directly or indirectly. The deaths of two Bush Stone-curlew chicks (one captive and one wild) have been linked to chemical insecticides in their environments. There are anecdotal reports of Bush Stone-curlews found dead after arsenic was applied to railway sleepers in South Australia (L. Wheaton pers. comm.).

Further investigation and monitoring is required to ascertain whether chemicals and insecticides currently used in field situations pose a threat to wild Bush Stone-curlew populations. As mentioned in Section 3.5.3, Bush Stone-curlews will consume pest species, such as locusts, and their nocturnal foraging habits within paddocks is likely to make them susceptible to ingesting insecticides. The reduction in foraging resources following insecticide application could also adversely affect breeding birds or chicks.

The DEC has taken a precautionary approach to locust control activities and recommends that the environmentally safe insecticide Metarhizium (or Green Guard™) be used within a 2km area around known Bush Stone-curlew sites during plague locust control activities.

Many commonly used agricultural insecticides are organophosphates and carbamates, which are known to have had adverse impacts on overseas bird species (Story and Cox 2001). Little research has been undertaken in Australia on the impacts to native fauna. Appendix 5 lists commonly used chemicals that are organophosphates and carbamates.

It is unclear whether the methods used for locust control could result in adverse impacts to individual Bush Stone-curlews, or populations. Further research is recommended (Action 8.2).

5.9 Simultaneous Factors

In reality, many of the above factors will be acting simultaneously, resulting in declines in Bush Stone-curlew numbers and a reduction in the area of suitable roosting, foraging and nesting habitat. Thresholds in habitat area or condition are reached, below which individuals of the species cannot be supported and populations become too small or fragmented to be viable. When these thresholds are approached, a single event (for example a fox attack on an adult bird, a fire or the clearing of a small area of habitat) may play a greater role in the general demise of a population than it otherwise would. In some urban and semi-rural locations, single birds have occurred for many years without any observed interactions with other Bush Stone-curlews (eg Narooma). These single birds probably represent the last survivors of a local population before it goes extinct. These local populations have presumably declined as a result of several pressures acting simultaneously.

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1 As at November 2005, DEC agreed to a 2km Metarhizium only area for aerial spraying and a 1km Metarhizium only area for on-ground spraying around Bush Stone-curlew sites during locust control activities.
6 Previous Recovery Actions

Many recovery actions have been undertaken or commenced by a variety of individuals, groups and organisations. The DEC (Biodiversity Conservation Unit, Reform and Compliance Branch) has provided for a portion of a project officer’s time to develop, coordinate and implement the recovery program. Although a formal recovery team has not been formed, an informal network of landholders, scientists, government officers and ornithologists have run the majority of the recovery actions since the publication of the draft recovery plan in 2003. Links have been made with local and state government officers working on Bush Stone-curlews in Victoria and South Australia so that a consistent recovery program for the species is implemented across mainland Australia.

6.1 Community awareness

In 1999 DEC, in conjunction with Birds Australia produced a Woodland Birds poster which included advice on Bush Stone-curlew habitat and management. In 2000, as part of the Plains-wanderer recovery program, a Wildlife Management Manual for threatened species in the Riverina region was produced by Western Threatened Species Unit. A profile on the Bush Stone-curlew was included in this manual and provided management advice to landholders.

As part of the Darling Riverine Plains Bioregional Assessment, a community awareness program was co-ordinated by DEC in 2000/01. One of the iconic threatened species in the Gulargambone-Collie area was the Bush Stone-curlew. A number of visits were made to properties where Bush Stone-curlews had been found during the surveys. Many landholders were interested in increased and co-ordinated fox control with the RLPBs.

In 2002, the DEC produced a brochure detailing habitat management information, threatening processes and biological facts on the Bush Stone-curlew. A poster designed to prompt members of the public to report sightings of the species was also produced and distributed to DEC offices and community groups. A community survey was undertaken across the state using local newspapers, radio and television to raise awareness of the decline of the Bush Stone-curlew and call for records. Respondents were sent a copy of the brochure. Records from the survey are being entered into the Atlas of NSW Wildlife.

In 2004, “Don’t flog our logs” stickers were produced by the Nature Conservation Working Group (NCWG) and DEC to raise awareness of the need for fallen timber by Bush Stone-curlews. The stickers have been given to school groups and used across the state in promotional activities. The NCWG also printed T-shirts, developed a Bush Stone-curlew puppet and undertook talks in schools to promote the species in the Murray area.

Articles on the recovery program have been published in Wingspan and Nature Australia magazines and several talks have been presented to bird watching, field naturalist and farmer groups across the state.

6.2 Research

The DEC provided funding to support two PhD students currently studying Bush Stone-curlew habitat and predation characteristics through Charles Sturt University. The students have undertaken field surveys to identify 30 pairs of Bush Stone-curlews and are working with landholders in the eastern Murray catchment and northern Victoria. Additional funding has been provided by Birds Australia. The studies commenced in March 2004 and are the first such projects to be undertaken on the Bush Stone-curlew.

A research project examining the conservation management of the Central Coast Bush Stone-curlew population was undertaken as part of a Masters degree through the University of Sydney and completed in 2004 (Price 2004). DEC provided funding and support for the project.

6.3 Bush Stone-curlew Summit

In March 2004, a Bush Stone-curlew Summit was held at Charles Sturt University, Albury. The aim of the Summit was to bring together the different people involved with Bush Stone-curlews to discuss options available for recovery and to meet the PhD students. Approximately 50 people attended, including landholders, scientists, representatives from several land management agencies such as DEC, Forests NSW, Victorian and South Australian conservation agencies. The Summit highlighted the need for further research and the importance of landholder support for the recovery program.

6.4 Locust Control and Pesticide Use

During locust control activities, the DEC, DPI and APLC have agreed to use the environmentally friendly insecticide Metarhizium (or Green Guard™) within 2km of known Bush Stone-curlew sites during aerial spraying and within 1km of
known Bush Stone-curlew sites during ground spraying, where possible (as at November 2005).

The University of Wollongong and DEC laboratories have undertaken autopsies on Bush Stone-curlew chicks to identify whether contaminants are implicated in the deaths of Bush Stone-curlew chicks. To date, one case of organophosphate poisoning has been recorded in a captive chick and organochloride contamination has been implicated at a site on the Central Coast.

6.5 Genetic analysis

CSIRO has been undertaking an analysis of the DNA of wild birds to assess whether there is any genetic evidence for subspeciation. This follows morphological work undertaken which suggests three subspecies occur in Australia (Mason and Schodde 2004 – draft). Initial analysis of mitochondrial DNA did not suggest that subspeciation had occurred however further work using microsatellites needs to be undertaken.

6.6 Population surveys and management

Five catchment management areas have been the focus of population surveys, on-ground works and community awareness activities – the Murray Catchment, mid-Lachlan Catchment (Weddin), Southern Rivers (Shoalhaven), Hunter-Central Rivers (Gosford-Pittwater and Port Stephens LGAs) and North Coast (Pottsville-Koala Beach). However several landholders in other areas have also undertaken significant actions on their properties, for example DEC Dubbo staff assisted a landholder on a property near Collie to erect an electric fence around Bush Stone-curlew habitat.

Hunter – Central Rivers CMA
(Gosford-Pittwater and Port Stephens LGAs)

A report to Gosford Council on the conservation status of the Bush Stone-curlew was prepared which identified the core areas of habitat in the Brisbane Water area (Morris 2002). A study of the resident population within this area and across to Careel Bay, Pittwater was subsequently undertaken (Price 2004) which recommended management actions at several sites and ongoing monitoring of breeding success.

A community group, “Friends of the Bush Stone-curlew” has been formed to assist with habitat management and monitoring programs following a public meeting in 2004. A newsletter, “the Curlew Cryer”, is sent to members of the group. DEC and Gosford Council provide support to the group and have undertaken surveys, colour leg banding of chicks, site management and monitoring activities.

Temporary electric fencing has been used to protect nest sites with success. Several talks have been presented by the DEC recovery coordinator to local bird groups and Land for Wildlife days to raise local awareness of the Bush Stone-curlew.

Gosford Council has contracted a consultant to undertake surveys to identify Bush Stone-curlew habitat and continue monitoring the local population. Fox trapping is being undertaken at Bush Stone-curlew sites where baiting is not possible.

Temporary safety fencing was used around a nesting site in Port Stephens LGA to protect breeding birds from disturbance on a public area. DEC, Port Stephens Council, local bird groups and local residents are involved in the management of the site. Chicks hatched at the site had colour leg bands applied to facilitate monitoring.

Lachlan Catchment CMA
(Forbes RLPB and Weddin Landcare)

CSIRO undertook Bush stone-curlew surveys (postal and field) over an 180,000 ha area to complement a community fox-baiting program being run by Forbes RLPB and Weddin West Landcare group across 150 properties. A report on the project was produced (Davey 2005) which documents the current status of the species within the area and recommends future management actions. Community meetings were held prior to and following the project to discuss the project with landholders. Ongoing support for the project is being provided by Forbes RLPB, Lachlan CMA and DEC.

Murray CMA

Since 2001 the Nature Conservation Working Group (NCWG), a catchment-based community conservation group, has supported a Bush Stone-curlew project officer to run a number of projects aimed at engaging landholders in Bush Stone-curlew conservation. Several activities have been undertaken including:

- All rural landholders within the Murray catchment were sent a survey to assess numbers of birds remaining and the level of interest in conservation activities. 80 landholders responded.
- Five permanent fences (4 electric) have been built to protect nest sites with significant input from landholders.
- Protection of several nest sites using temporary electric fences.
- Groups of shooters matched to Bush Stone-curlew sites to control foxes and feral cats.
• Public talks at Deniliquin, Moulamein, Pleasant Hills, Walla and Holbrook and 10 local schools, and several media interviews in local papers, radio and magazines.
• Involvement in and promotion of fox-baiting programs.
• Development of promotional materials such as stickers, T-shirts and a Bush Stone-curlew talking puppet.
• Establishment of a captive-breeding program - two private properties have aviaries holding up to 20 captive birds and soft-release areas.
• Provision of Bush Stone-curlew habitat management advice to landholders, including updating habitat management brochure.

The Hume Rural Lands Protection Board (RLPB) has undertaken fox-baiting programs on and around several Travelling Stock Routes which support Bush Stone-curlews within the eastern Murray Catchment. Habitat management activities have focussed on fox-control and retention of fallen timber within sites.

Northern Rivers CMA
(Koala Beach Estate – Hastings Point)

A small population of Bush Stone-curlews is being monitored during the development of a residential estate at Hastings Point, Tweed LGA. Local residents have been involved in the conservation of the birds and management measures to mitigate the impact of introduced predators and traffic have been implemented.

Southern Rivers CMA
(Shoalhaven)

Community and field surveys were undertaken by DEC in 2003/04 following sightings of a breeding pair of Bush Stone-curlews in South Nowra in 2003 at a development site. Unfortunately no additional records have been confirmed, although suitable habitat is available.

7 Recovery Objectives, Actions and Performance Criteria

7.1 Overall Objective

The overall objective of this Recovery Plan is to manage at least five populations of the Bush Stone-curlew across NSW to ensure they are secure and consistently increasing in both extent of occurrence and area of occupancy over the 5 years of the plan.

To do this we need to increase our understanding of the ecology and conservation management of the Bush Stone-curlew, conserve its habitat, reverse the continuing decline in abundance of the species and actively manage local populations with community and government support.

Until the biological and ecological information required to assess populations dynamics is known, a ‘population’ can be defined by a suitable management unit, for example an LGA, CMA or National Park Area.

7.2 Recovery Actions

The recovery actions have been written to complement each other. The actions attempt to address the factors preventing recovery of the Bush Stone-curlew, including lack of knowledge of species ecology and lack of adequate consideration in the planning process. In addition, the recovery actions promote direct action in several areas, particularly conservation and management of habitat (Objective 1 and 3).

While support for the implementation of the actions in the recovery plan resides with the DEC, other organisations have been suggested which may also provide support for implementation of recovery actions. It is noted that these organisations have not agreed to be responsible for the implementation of these actions. Other parties, such as interested individuals, are encouraged to implement recovery actions, where appropriate.

Objective 1: Expand existing Bush Stone-curlew community conservation programs.

Performance Criteria: At least five populations of the Bush Stone-curlew occurring in 5 different CMAs in NSW with funded habitat management and monitoring programs.

Performance Criteria: Community groups involved in Bush Stone-curlew conservation supported in at least 5 CMAs.

Existing Bush Stone-curlew projects are priorities for DEC support and funding given the level of existing community support and the availability of current data (see Previous Recovery Actions).

Action 1.1: Support existing community Bush Stone-curlew recovery projects.

Suggested implementation partners: CMAs, local councils.
Several community projects are ongoing and have previously received funding. These projects have led to direct on-ground management actions being implemented, for example fox control programs and nest site protection in addition to raising levels of public awareness. Community projects can complement research projects, facilitating the collection of information on distribution, breeding success, and habitat use. Community involvement is essential for the recovery of the Bush Stone-curlew. The continued support of these groups will provide long-term benefits to local populations of Bush Stone-curlews.

The following community groups and Bush Stone-curlew projects are recognised as a high priority for support from the recovery program:

- Nature Conservation Working Group – Murray CMA
- Weddin Landcare group – Lachlan CMA
- Brisbane Waters ‘Friends of the Bush Stone-curlew’ group – Hunter-Central Rivers CMA.

Other priority areas which require support to expand or develop community projects are:

- Hunter-Central Rivers CMA - Port Stephens and Great Lakes areas
- Northern Rivers CMA – Pottsville/Koala Beach and west of Murwillumbah
- Central West CMA – Collie/Gilgandra/Gulargambone area.
- Murrumbidgee CMA

**Objective 2: Raise community recognition of the Bush Stone-curlew and interest in the recovery program.**

**Performance criteria:** Public talks held in all CMAs and at least 5 articles published in statewide publications.

**Performance criteria:** Hold at least one Bush Stone-curlew Summit bringing together landholders, ornithologists, community representatives, researchers, local and state government officers from across Australia.

**Performance criteria:** Bush Stone-curlew PR materials distributed throughout NSW and a revenue stream established through sale of toys, T-shirts and other products.

**Action 2.1: Raise the profile of the Bush Stone-curlew through publicity activities.**

Suggested implementation partners: CMAs, local councils, RLPBs, community groups, researchers.

To enhance general public awareness of the Bush Stone-curlew and its conservation needs, publicity activities should be undertaken across the state, particularly in priority CMAs. Activities such as public talks in areas supporting Bush Stone-curlews and the publication of articles in non-scientific magazines are encouraged.

**Action 2.2: Maintain and distribute Bush Stone-curlew promotional and community education materials**

Suggested implementation partners: CMAs, local councils, community groups, bird watching clubs.

Several promotional and community education materials have been developed by DEC and the NCWG (see Previous Actions section). These include a habitat management brochure, a poster and a sticker. The Bird Observers Club of Australia has produced a cassette and CD of the Bush Stone-curlew call. Stocks of these materials will be maintained and distributed for use in community awareness programs across the state, particularly within priority CMAs. The brochure and poster can be updated when needed and reprinted with local contact details, if necessary.

**Action 2.3: Facilitate and support the distribution and sale of Bush Stone-curlew promotional materials, such as puppets and T-shirts to raise funds for conservation activities.**

The NCWG developed a Bush Stone-curlew puppet and T-shirts to raise funds for conservation activities. The sale of products to raise funds for community groups to undertake conservation activities which raise the profile of the Bush Stone-curlew will be supported.

**Action 2.4: Hold a “Bush Stone-curlew Summit” to bring together people working on Bush Stone-curlew conservation from across NSW.**

Suggested implementation partners: CMAs, local councils, community groups, research organisations.

In year 3 of the implementation of the recovery plan, a Bush Stone-curlew Summit will be held to bring together people who are working on the species. Participants will include landholders,
researchers, CMA officers, council officers, bird watchers, RLPB officers and DEC staff, with the aim of getting people together to establish and maintain links and disseminate information. The Summit will include a tour of local properties involved in Bush Stone-curlew conservation projects.

Objective 3: Increase the total area of Bush Stone-curlew habitat protected and managed for conservation on public and private lands by 25% in each CMA.

Performance Criteria: Distribution and abundance data for all Catchment Management Authorities (CMAs) in NSW published and distributed to relevant land managers.

Performance Criteria: Community (media) and field surveys on private and public land undertaken within 6 CMAs.

Performance Criteria: Bush Stone-curlew field surveys undertaken on all DEC lands which have records of Bush Stone-curlews or support suitable habitat.

Performance Criteria: Multi-property introduced predator control programs established at a minimum of 10 locations known to support Bush Stone-curlews (including monitoring for both native and introduced fauna).

Performance Criteria: Community groups involved in Bush Stone-curlew conservation occurring in at least 5 CMAs.

Performance Criteria: Increase by 25% the area of private land in each high priority CMA managed for Bush Stone-curlews, for example by retention of fallen timber, predator control programs and managing grazing.

Performance Criteria: Area of DEC lands supporting Bush Stone-curlews to increase through reservation.

Performance criteria: At least five populations of the Bush Stone-curlew occurring in 5 different CMAs in NSW with funded habitat management and monitoring programs.

However, these actions should be implemented wherever Bush Stone-curlews occur in NSW.

Community groups and landholders have not been listed as responsible for implementation of these actions as their involvement is voluntary. However, both groups will play a large role in the collection of information and management of habitat and their contribution is acknowledged and encouraged.

Action 3.1: Identify and map suitable Bush Stone-curlew habitat - foraging, breeding and roosting habitat should be identified.

Suggested partners for implementation: CMAs, local councils, RLPBs, Dept of Lands, DPI (Forests and Agriculture), community groups, research institutions.

The identification and mapping of suitable Bush Stone-curlew habitat will also identify opportunities to undertake and/or expand conservation programs. It will also allow the area of Bush Stone-curlew habitat currently being managed for conservation to be calculated so that a 25% increase over 5 years can be measured (see Objective 3).

Action 3.2: Undertake community and field surveys within areas of habitat (breeding, foraging and roosting) to identify Bush Stone-curlew sites.

Suggested partners for implementation: CMAs, local councils, RLPBs, Dept of Lands, DPI (Forests NSW and Agriculture), community groups (particularly bird clubs), research institutions.

Community surveys should utilise local media outlets and record historical and current observations. Field surveys should use the survey guidelines in Appendix 4.
**Action 3.3:** Undertake integrated predator and pest control programs in areas of Bush Stone-curlew habitat, with a particular emphasis around breeding sites.

Suggested partners for implementation: RLPBs, CMAs, local councils, Dept of Lands, DPI (Forests NSW and Agriculture), community groups, research institutions.

Multi-property or landscape scale programs are highly recommended. Fencing of breeding sites can also be considered if suitable long-term management of the site is available or other predator control methods are restricted or considered to be ineffective.

Predator and pest control programs must include a mechanism to demonstrate that the control program is working. Monitoring numbers of pest species prior to and over the course of the control program is recommended.

RLPBs are the primary point of contact when undertaking predator and pest control programs, and their involvement is encouraged.

**Action 3.4:** Undertake annual monitoring programs during the breeding season to determine breeding success, juvenile recruitment and status of population.

Suggested partners for implementation: CMAs, local councils, RLPBs, Dept of Lands, DPI (Forests NSW), community groups, research institutions

To facilitate monitoring, colour leg bands should be applied to chicks at approximately 6 weeks of age to assist in the identification of birds post-fledging. Leg banding can only be conducted by a ABBBS licensed person. Animal ethics and DEC licensing requirements will also need to be met for this activity. Call play-back and visual observations of birds are suggested methods for monitoring and surveying for Bush Stone-curlews.

Data to determine whether a population is increasing, stable or declining will be gathered by monitoring programs.

**Action 3.5:** Manage Bush Stone-curlew habitat with particular focus on:
- predator control (especially foxes, dogs and cats)
- retention of fallen timber
- ground cover length and shrub cover
- weed management
- stock access and grazing (particularly during nesting)

- application of chemicals (especially insecticides)
- proximity and size of roost sites - regeneration and rehabilitation
- minimisation of disturbance to birds from human activities, especially during the breeding season
- long-term site security and viability

Suggested partners for implementation: CMAs, local councils, RLPBs, Dept of Lands, DPI (Forests NSW), community groups, research institutions.

Guidelines for managing Bush Stone-curlew habitat are found in Appendix 2 and Appendix 3, however seeking expert advice is also recommended. The recovery coordinator will provide information on suitable management actions and facilitate liaison between land managers and experts to ensure an adaptive approach is taken to the management of Bush Stone-curlew habitat.

**Action 3.6:** Apply for off-label permits to undertake 1080 baiting in areas supporting breeding Bush Stone-curlews where fox-baiting programs are otherwise not permitted.

Suggested partners for implementation: CMAs, local councils, RLPBs, Dept of Lands, DPI (Forests NSW).

In many areas Bush Stone-curlews occur close to or within urban areas, for example in Gosford and Port Stephens LGAs. Where nesting sites are threatened by foxes, land managers should apply for an off-label permit to undertake 1080 baiting. Permits are granted in certain circumstances when strict monitoring and compliance conditions can be met and are only suitable for government agencies or authorities.

Fox trapping, using cage or soft-jaw leg-hold traps, can also be conducted by pest control contractors.

**Action 3.7:** Protect and manage Bush Stone-curlew habitat on public land.

Suggested partners for implementation: CMAs, local councils, RLPBs, Dept of Lands, DIPNR, DPI, SCA, Department of Defence, DEH

Bush Stone-curlew habitat on public land is considered a high priority for conservation management and protection, particularly breeding and roosting habitat. Consistently used and successful breeding sites are considered the highest priority for protection, management and conservation. Available conservation mechanisms will depend on the tenure and zoning of the land, but rezoning or acquisition by DEC should be
considered. Active conservation and management of public land is a high priority to conserve Bush Stone-curlew habitat (see Action 5.5 for issues which need consideration when undertaking site management).

Public land which has not been reserved for conservation may support suitable habitat, for example the Linear Reserves Program undertaken by the Murray Regional Organisation of Councils provides for management plans to be prepared for native vegetation on major roadsides and other reserves.

**Action 3.8: Facilitate conservation of Bush Stone-curlew habitat on private land.**

**Suggested partners for implementation:** CMAs, local councils, community groups.

The majority of Bush Stone-curlew habitat occurs on private land. Support and encouragement should be provided to landholders to manage habitat sympathetically to meet the requirements of the Bush Stone-curlew. The use of all available mechanisms (for example, Land for Wildlife, covenants, voluntary conservation agreements and wildlife refuges) should be encouraged to conserve Bush Stone-curlew habitat on private land. Technical advice and support (for example, through the provision of equipment or labour) should be provided to landholders willing to conserve Bush Stone-curlew habitat on their properties. Funding should be sought to provide equipment and resources, such as fencing materials, baits, weed control, herbicides.

Employing a dedicated project officer position to run community extension activities is recommended as the most effective method of engaging and supporting landholders within a local area. The position could sit within DEC regional offices, CMAs, local councils or a community group.

**Action 3.9: Establish and support community groups to undertake habitat management activities, assist with monitoring and surveys, and record opportunistic sightings. Community newsletters are encouraged.**

**Suggested partners for implementation:** CMAs, local councils, RLPBs, DPI

Local community groups play an important role in the recovery of the Bush Stone-curlew. Community involvement and support for conservation issues is vital to the long-term security of local Bush Stone-curlew populations. Community groups can apply for grants to undertake conservation and management works on private and public lands. They are stakeholders in land management and planning decisions and can increase community understanding of and support for conservation issues.

**Action 3.10: Prepare and implement management plans for local Bush Stone-curlew populations. Source funding to implement management plans.**

**Suggested partners for implementation:** CMAs, local councils, community groups.

Management plans are to be prepared for each local Bush Stone-curlew population. The Management Plans should focus on protection and management of breeding sites and address site-specific management issues, ongoing monitoring of populations, identification of responsible land managers and links to DEC recovery program.

Securing funding to implement the Management Plans is a high priority.

**Action 3.11: DEC to acquire Bush Stone-curlew habitat when land acquisition opportunities arise. Priority regions for habitat acquisition to be determined.**

Bush Stone-curlews generally occur in lowland grassy woodland vegetation communities which are under represented within the conservation reserve system in NSW, both in coastal and inland areas. In conjunction with landholders and community groups, the DEC will identify priority regions within which the acquisition of Bush Stone-curlew habitat will be pursued. Properties will only be purchased with the support and cooperation of the landowner or where Crown land can be transferred to the DEC. Land acquisition in these circumstances will assist in securing the long-term viability of a local population of Bush Stone-curlews in addition to benefiting a range of other threatened species or vegetation communities.

Properties currently being assessed for acquisition which support Bush Stone-curlews or their habitat should be a high priority for acquisition. The recovery coordinator will liaise with the relevant DEC Branch to ensure acquisition priorities recognise the habitat requirements of the Bush Stone-curlew.
Objective 4: Supplement declining wild populations with a robust and well-funded captive-breeding and translocation program.

Performance criteria: Establishment of a genetically managed captive population within Australasian Regional Association of Zoological Parks and Aquaria (ARAZPA) institutions with a studbook keeper.

Performance criteria: Priority sites for translocation identified.

Performance criteria: Funding secured for long-term management and monitoring programs at translocation sites.

Captive-breeding and translocation is a method of supplementing wild Bush Stone-curlew populations which are declining and extinction is likely. Given the long-term commitments required, resources needed and the complex ecological issues concerned, translocations cannot replace in situ conservation programs as described in Objective 3. Without in situ conservation programs focussing on long-term habitat management and predator control, translocations will fail. Additionally, the ongoing monitoring of release sites and released animals is paramount to the long-term success of a translocation program and to the recovery program as a whole.

Translocations to supplement declining wild populations will be supported in areas where habitat remains and is secure, and resources are available to manage the habitat over the long-term. This includes the identification, control and monitoring of threatening processes. Priority areas for translocations to occur still need to be identified (Action 4.2).

The Nature Conservation Working Group (NCWG) within the Murray CMA has established two captive-breeding facilities on private properties with the aim of releasing captive-bred birds back into the wild.

Action 4.1: Establish and maintain robust and genetically-managed captive populations suitable for use in captive-breeding programs.

Suggested implementation partners: NSW Zoological Parks Board, ARAZPA institutions, research institutions, NCWG

Robust and genetically-managed captive populations are required to supplement wild Bush Stone-curlew populations which are in decline. In order to maintain suitable captive populations over the long-term, expertise in small population management will be required and a studbook for the species kept.

Action 4.2: Identify priority sites for trial Bush Stone-curlew translocation into the wild.

Priority sites for Bush Stone-curlew translocation will be identified. Considerations for site selection include:

- area of habitat and its likelihood of supporting a viable population
- potential impacts on a wild Bush Stone-curlew population,
- ability to manage predators and habitat over the long-term,
- ability to undertake monitoring of released birds, and
- the level of community support for the release of a threatened species.

Suggested implementation partners: CMAs, local councils, RLPBs, DPI (Forests NSW), research institutions, community groups.

Action 4.3: Prepare translocation proposal and seek relevant approvals and licences.

Suggested implementation partners: NCWG, species experts, research institutions.

To undertake translocations in NSW, a translocation proposal must be approved by DEC. The proposal must address the DEC Policy for the Translocation of Threatened Fauna. The translocation proposal will address site selection, assessment of impacts, management of sites and ongoing monitoring to ascertain the success of the project. Animal ethics approvals and DEC scientific licences area also required as part of the approval process.

The translocation proposal will be prepared in consultation with all stakeholders, including DEC, captive-breeding partners, release site managers and individuals involved in post-release monitoring. A review of relevant scientific literature and projects will be undertaken during the preparation of the translocation proposal to ensure the most up-to-date and relevant methods are used.
**Action 4.4: Secure funding for post-release monitoring and habitat management.**

Suggested implementation partners: CMAs, local councils, WWF TSN, Foundation for National Parks and Wildlife, NCWG, research institutions.

To ensure the success of a translocation, funding for post-release monitoring of Bush Stone-curlews and ongoing habitat management will be secured.

**Action 4.5: Implement translocation proposal and maintain monitoring to assess success.**

Following approval by DEC and having secured funding, the translocation proposal will be implemented. Continued monitoring and the publication of results are considered important to the overall success of the translocation.

Suggested implementation partners: research institutions, community groups, RLPBs, DPI (Forests NSW).

**Objective 5: Ensure the conservation status of the Bush Stone-curlew is adequately recognised under NSW and Commonwealth legislation.**

**Performance criteria:** An assessment of the conservation status of the Bush Stone-curlew undertaken.

**Action 5.1:** Assess status of the Bush Stone-curlew against the listing criteria of the Commonwealth Environment Protection and Biodiversity Conservation Act 1999, and prepare a nomination if warranted.

Suggested implementation partners: Research institutions, species experts, interstate conservation agencies.

The EPBC Act recognises nationally threatened species and populations. Current knowledge of the Bush Stone-curlew indicates that it may either meet the criteria for being nationally threatened or that the southeastern Australian population (ie within NSW, Victoria and South Australian mainland) of the species may meet the criteria for an endangered population (under section 517 of the EPBC Act). A nomination should be prepared, if warranted, following an assessment of the conservation status of the species against the criteria for either nationally threatened or a threatened population across NSW, Victoria and South Australian mainland.

**Action 5.2:** Assess the Bush Stone-curlew against the listing criteria for “critically endangered” under the NSW Threatened Species Conservation Act (as amended by the TSLA Act 2004). Prepare a nomination, if warranted.

Suggested implementation partners: Research institutions, species experts, interstate conservation agencies.

The TSLA Act amended the TSC Act to create a “critically endangered” category. Recent surveys and records of breeding success indicate that the Bush Stone-curlew may qualify for listing under this new category. An assessment should be undertaken and a nomination prepared, if found to meet the criteria.

**Objective 6: Ensure that impacts on Bush Stone-curlews and their habitat are accurately assessed during planning and environmental assessment processes.**

**Performance criteria:** EIA guidelines for the Bush Stone-curlew distributed to all local councils and published on the DEC website.

**Performance criteria:** An assessment of the effectiveness of PVPs in conserving and managing Bush Stone-curlew habitat undertaken.

**Performance criteria:** Metarhizium used within all mapped Bush Stone-curlew habitat.

**Action 6.1:** Prepare environmental impact assessment (including survey) guidelines for use when assessing the impacts of developments and activities under the EP&A Act and TSC Act. Distribute to state and local government agencies and make available on DEC website. Guidelines to be checked and updated annually to ensure new information is included.

Suggested implementation partners: local councils, species experts.

These guidelines will provide information to consent authorities and investigators regarding adequate survey methods, assessment priorities for protection and conservation of sites and impact mitigation measures suitable for various types of developments. The guidelines are to be checked and updated regularly to ensure that new information is included. This is particularly emphasised during the life of the recovery plan as several long-term research projects and monitoring
studies are being undertaken which should provide better information than is currently available.

**Action 6.2: Facilitate the adequate consideration of Bush Stone-curlews during biodiversity certification of environmental planning instruments (under the TSLA Act).**

Suggested implementation partners: local councils

At the time of writing it was unclear how biodiversity certification of EPIs would be undertaken. This action is to ensure that where Bush Stone-curlew habitat occurs within an area undergoing biodiversity certification by the Minister for the Environment, consideration of Bush Stone-curlews is undertaken using appropriate information. This may include ensuring that correct survey methods are used and informed habitat assessments are undertaken, that up-to-date information is used and that adequate conservation measures are included in the EPI to assist in the recovery of the species. Conserving habitat to enable populations to recover and be viable in the long-term should be a principle consideration in areas supporting Bush Stone-curlews.

The highest priority for recovery of the species is the conservation and protection of breeding habitat. Repeatedly used and successful breeding sites should be given the highest priority for protection and management.

**Action 6.3: Ensure up-to-date and accurate Bush Stone-curlew species and habitat information is being used in the “PVP Developer - Threatened Species Tool”**.

Suggested implementation partners: DIPNR, CMAs

The DIPNR and DEC have developed a software program called the “PVP Developer” to assess clearing applications and deliver incentives for private land conservation under the *NSW Native Vegetation Act 2003*. One part of the “PVP Developer” - the Threatened Species Tool - assesses impacts on threatened species, populations and ecological communities, and will remain the responsibility of the DEC to maintain. Ensuring that information in the Threatened Species Tool is accurate and based on the most up-to-date knowledge is imperative to ensuring that the impacts of clearing applications on Bush Stone-curlew are being accurately assessed and habitat is appropriately managed on private land across the state.

**Action 6.4: Assess effectiveness of Property Vegetation Plans (both offset and incentive versions) in providing for the conservation of Bush Stone-curlews and their habitat. If this is not happening, identify why not and provide formal feedback to responsible managers within DEC, DIPNR and CMAs.**

Suggested implementation partners: DIPNR, CMAs, research institutions.

PVPs are a new approach to regulating the clearing and management of native vegetation on private land. As the number of PVPs developed and implemented grows, it will be important to assess if they are delivering their intended aim of “improving or maintaining” environmental outcomes, including the conservation of threatened species and their habitat. During year 3 of this recovery plan, an assessment of the effectiveness of PVPs should be undertaken involving liaison with landholders, CMA officers and DEC officers. If a lack of effectiveness is identified, this feedback should be formally provided to relevant managers within DEC, DIPNR and CMAs and suggestions made to improve effectiveness.

**Action 6.5: Ensure records from surveys and assessments are entered on the Atlas of NSW Wildlife accurately and quickly.**

Suggested implementation partners: all involved in recovery projects.

Given the widespread and increasing use of the Atlas of NSW Wildlife for numerous planning, research and conservation activities, it is imperative that all Bush Stone-curlew records from across NSW are entered onto the Atlas of NSW Wildlife accurately and in a timely manner.

The recovery coordinator should facilitate this process by providing a central collection point for records held by community groups, landholders or bird watchers.

**Action 6.6: Obtain Bush Stone-curlew records held by other organisations and agencies for inclusion on the Atlas of NSW Wildlife.**

Suggested implementation partners: Birds Australia, regional bird watching clubs and field naturalist clubs.

It is understood that several bird watching organisations hold databases with species records that are not included on the Atlas of NSW Wildlife. The development of a process to obtain regular updates of new Bush Stone-curlew sightings from
several organisations, including Birds Australia, Bird Atlassers, Bird Observers Club of Australia and local bird watching groups should be investigated.

Given the role these groups play in providing support to the recovery program, a small amount of funding could be provided for the supply of records where possible.

**Action 6.7:** Ensure that the Threatened Species Hazard Reduction List is accurate and up-to-date regarding management of impacts to Bush Stone-curlews and their habitat.

Suggested partner for implementation: RFS

The Threatened Species Hazard Reduction List is a component of the Bushfire Environmental Assessment Code. It describes conditions on the use of fire and other mechanical forms of hazard reduction activities to minimise adverse impacts on threatened species. The recovery coordinator will ensure information contained in the Threatened Species Hazard Reduction List is up-to-date and accurate based on current knowledge.

**Action 6.8:** Assess implementation and effectiveness of Threatened Species Licence conditions (TSL) under the Integrated Forestry Operations Approvals (IFOAs) and renegotiate conditions, if appropriate.

Suggested implementation partner: DPI (Forests NSW).

Under the IFOAs, specific conditions apply if a Bush Stone-curlew nest site is recorded during pre-logging surveys. However, given the practical difficulties in locating nest sites it remains debatable whether the surveys are adequate. The TSLs effectiveness in reducing the impacts of forestry activities on Bush Stone-curlews will be assessed and renegotiated, if appropriate.

**Action 6.9:** Support the use of Metarhizium (Green Guard™) within Bush Stone-curlew habitats and within a 2km radius around Bush Stone-curlew sites on non-DEC lands during locust control activities. Metarhizium (Green Guard™) to be used on DEC lands supporting Bush Stone-curlew habitat.

Suggested implementation partners: DPI (Agriculture), RLPBs, APLC

When undertaking locust control activities, DEC has recommended that Metarhizium (Green Guard™) be used within a 2km radius around Bush Stone-curlew records during aerial spraying and within a 1km radius during ground spraying. Metarhizium should also be used within mapped Bush Stone-curlew habitat. The authorities responsible for locust control, including RLPBs, DPI and APLC, are responsible for implementing this measure. DEC will provide Bush Stone-curlew records and habitat mapping to relevant authorities for use in locust control planning activities.

**Objective 7: Increase understanding of the ecology of the Bush Stone-curlew.**

**Performance criteria:** Studies on Bush Stone-curlew biology and ecology in NSW published in peer-reviewed journals.

**Performance criteria:** Ability to assess long-term viability of Bush Stone-curlews.

**Action 7.1:** Undertake research into Bush Stone-curlew ecology.

Suggested implementation partners: DPI (Forests NSW), research institutions, CMAs, local councils, RLPBs, community groups.

At present there are large gaps in our understanding of specific habitat requirements of Bush Stone-curlews, in particular foraging, nesting and roosting habitats. Basic ecological research is required to enhance our understanding of habitat usage and requirements at both the macro- and micro-habitat scale. Home range size in different environments and during breeding and non-breeding seasons, juvenile dispersal distances, and population dynamics are topics which need further research.

To gain an increased understanding of Bush Stone-curlew ecology, the DEC will undertake and support research in these areas. Preferred research projects will be those which have a link to conservation management activities and focus on an adaptive management approach.

**Action 7.2:** Develop protocols to monitor Bush Stone-curlew populations and methods for assessing long-term population viability.

Suggested implementation partners: DPI (Forests NSW), research institutions, CMAs, local councils.
Research projects which develop monitoring protocols for Bush Stone-curlew populations to assist assessments of population viability will be supported. Monitoring protocols are needed to assess population size and species abundance, juvenile recruitment and breeding success. Monitoring will provide data from which estimates of population viability can be made. The establishment and/or maintenance of at least 5 viable populations is the overall objective of the recovery plan.

**Action 7.3: Examine the genetic variability between and within populations of Bush Stone-curlews, and develop protocols for collection and storage of genetic material.**

**Suggested implementation partners:** Australian Museum, research institutions

Studies to examine and record genetic variability between populations and within populations will be supported. Particular emphasis should be placed on identifying whether subspecies exist across Australia, as has been suggested by Mason and Schodde (2004). Genetic studies may be able to provide information on juvenile dispersal and metapopulation dynamics. Genetic tools can be used to identify individuals and techniques are constantly improving, and should be embraced as a non-invasive method of survey and identification, where (if) possible.

Protocols for the collection, transport and storage of genetic materials, such as eggs, feathers, blood samples, will be developed to assist the consistent collection of this material during field studies.

Genetic studies will inform the selection of appropriate animals for captive-breeding programs and future translocations. Until this information is available, a precautionary approach should be taken.

**Action 7.4: Increase understanding of the biology of the Bush Stone-curlew.**

**Suggested implementation partners:** Zoological Parks Board of NSW, research institutions

An increased understanding of the biology of the Bush Stone-curlew, particularly regarding breeding and survival of individuals, will enhance the effectiveness of conservation management programs. Preferred biological studies will focus on areas which add information needed for recovery programs.

**Objective 8: Increase understanding of threatening processes affecting Bush Stone-curlews.**

**Performance criteria:** Studies investigating threatening processes affecting Bush Stone-curlews in NSW published in peer-reviewed journals.

Key threatening processes, as listed under the TSC Act, which are of relevance to the Bush Stone-curlew include the clearing of native vegetation, removal of dead wood, high frequency fire, invasion of native vegetation by exotic grasses, predation by the red fox and predation by the feral cat.

**Action 8.1: Undertake studies examining the impact of introduced species on Bush Stone-curlews.**

**Suggested partners for implementation:** DPI (Forests NSW and Agriculture), RLPBs, CMAs, research institutions

Preferred studies will provide information on the interactions between introduced species, such as foxes, dogs, cats and rabbits, with Bush Stone-curlew abundance, distribution and habitat use. Studies should aim to provide information which will improve the effectiveness of conservation management programs.

**Action 8.2: Undertake studies examining the impact of chemicals on Bush Stone-curlews.**

**Suggested partners for implementation:** APLC, DPI, Australian Wildlife Health Network, National Residue Survey (AFFA), research institutions

Anecdotal and some field evidence suggests that the application of chemicals, such as arsenic, organochlorides and organophosphates could have had historical impacts on Bush Stone-curlews in southeastern Australia either through direct poisoning of individual birds, indirect effects of poisoning or removal of foraging resources. It is unclear whether the application of certain chemicals, for example organophosphate insecticides, continue to affect Bush Stone-curlew populations.

DEC will support studies to examine whether individual or population level impacts on Bush Stone-curlews result from the application of various chemicals. DEC support will be through the provision of ecological information and other relevant assistance, and support for grant applications to funding bodies. The development of links between researchers and groups interested
Objective 10: Integrate the recovery plan with other conservation plans and programs to maximise the efficient use of resources and benefits to biodiversity.

**Performance criteria:** Bush Stone-curlew recovery actions implemented through at least three other conservation programs.

**Objective 11: Implement a well-funded and coordinated recovery program across NSW.**

**Performance criteria:** Adequate funding obtained to implement actions and meet performance criteria.

**Performance criteria:** The maintenance of a DEC coordinated recovery program through the life of the recovery plan.

**Action 11.1:** Source funding to implement recovery actions and facilitate the preparation of grant applications where appropriate.

**Suggested implementation partners:** CMAs, local councils, research institutions, community groups.

To implement this recovery plan, significant amounts of funding need to be obtained. Funding is available from a variety of sources and is given to different applicants for differing purposes, for example community groups for on-ground works or research institutions for scientific research. The recovery coordinator will seek opportunities for different stakeholders in the recovery program to obtain funding to implement recovery actions, and facilitate the preparation of grant applications, where appropriate.
Action 11.2: Establish a recovery team and interstate working group to review recovery plan and prioritise implementation of actions.

A recovery team will be established to review the recovery plan and prioritise the implementation of actions. Financial support for team members will be provided by their organisation, however travel costs for two community representatives could be provided by DEC if necessary. The formation of an interstate working group will also be encouraged to facilitate a consistent approach to recovery of the Bush Stone-curlew across southeastern Australia and sharing of information.

Action 11.3: Coordinate implementation of recovery actions and provide support to regional projects

DEC will employ a Project Officer to coordinate and implement the recovery actions. The recovery coordinator will ensure that recovery actions complement each other and that information is transferred between projects. Support will be provided to regional projects to ensure that a consistent, but adaptive approach is undertaken and that the findings of research projects are incorporated into management projects. Regular communication between recovery coordinator and project coordinators will be supported.

8 Implementation

Table 1 allocates responsibility for the implementation of the recovery actions specified in this plan to relevant government agencies and/or parties for a period of 5 years from the time this recovery plan is adopted, and identifies costs associated with each recovery action. The total additional cost to DEC for the implementation of these actions is $650,800 plus $500,000 for land acquisition. Significant external funds will be required to support many of the actions, and this will be sought from CMAs and non-government sources.

The plan has been developed with the aim of maintaining a coordinator to undertake the statewide actions, to secure funding, to facilitate priority research projects and to assist regional officers and community groups undertake on-ground conservation actions. The coordinator’s role is to ensure that an adaptive management approach is undertaken whereby the results of research are incorporated into on-ground management actions and to ensure funding is allocated to priority projects.

On-ground conservation management activities will be undertaken by regional DEC officers, CMA officers, local council officers and community groups.

Further details of the costings are available from the Biodiversity Conservation Unit, Reform and Compliance Branch, Environment Protection and Regulation Division.

9 Social and Economic Consequences

It is extremely difficult to calculate the economic and social costs and benefits of recovering an endangered species, such as the Bush Stone-curlew. The species is widely distributed in NSW and our knowledge of its distribution and abundance is reasonably poor. Ascertaining the exact number of sites that may require conservation activities across NSW and the implications of those activities in terms of economic losses or gains is virtually impossible.

However, certain factors relevant to land management and current regulations within NSW limit the economic costs directly attributable to the implementation of this recovery plan. These factors include:

- the exemption of routine agricultural activities from requiring a licence under the TSC Act,
- the implementation of PVPs and the changes to native vegetation management across NSW,
- the voluntary nature of private land conservation activities,
- the funding provided to CMAs to provide incentives to landholders undertaking conservation activities on their properties,
- the ability of Bush Stone-curlews to utilise disturbed habitats and coexist with grazing activities in many circumstances.

Despite these factors, it is appreciated that economic costs will be born by landholders involved in Bush Stone-curlew conservation activities, or where the presence of Bush Stone-curlews on private land reduces the development potential of the land. The types of costs that may be incurred include:

- costs of time and labour provided by landholders involved in conservation projects,
- monetary costs incurred by landholders involved in conservation projects,
- potentially reduced agricultural profits where grazing is restricted as a result of nesting birds, although this is generally extremely minimal,
- potentially reduced agricultural profits if the use of certain locust control insecticides are not permitted, however
The Bush Stone-curlew has the potential to play an effective and important role in raising the general community’s awareness of conservation and biodiversity issues. Already several promotional materials have been developed which can be used to raise revenue for and awareness of the species, such as T-shirts and toys. By undertaking active education and awareness campaigns targeting local residents and landholders, people who would otherwise never encounter a threatened species are able to take an interest and be involved in a valuable conservation project at a level which is suitable to them.

10 Biodiversity Benefits

The main biodiversity benefit, other than the increased viability of the Bush Stone-curlew in the wild, arising from the recovery of the Bush Stone-curlew will be the conservation of species and ecological communities which co-exist with the Bush Stone-curlew or utilise similar habitats. The Bush Stone-curlew is a popular species with landowners and its conservation can both directly and indirectly assist the conservation of other declining and threatened species and ecological communities in NSW. In particular, other ground-nesting birds such as Banded Lapwings and Speckled Warblers will benefit from the reduction in introduced predator numbers and the increase in community awareness of the issues. Additionally, species which utilise fallen timber on the ground such as invertebrates, reptiles, small mammals and other birds will also benefit from an increase in this habitat resource.

The Central-west Bioregions (Darling Riverine Plain, Riverina and Cobar Peneplain) are key areas for the Bush Stone-curlew. These Bioregions, with the Broken Hill Complex in the Far West, are the least adequately reserved in NSW under the CAR targets of ‘comprehensiveness, adequacy and representativeness’ (as at September 2005) (DEC unpublished data).

Bush Stone-curlews commonly occur in the same areas as other threatened birds such as the Regent Honeyeater, Painted Honeyeater, Swift Parrot, Turquoise Parrot, Superb Parrot and about 40 other species of declining woodland bird (Robinson 1993). Moreover, lowland native grassy woodlands contain a large number of threatened plants (Briggs and Leigh 1988).
11 Preparation Details

This document was prepared by Catherine Price of the DEC (Biodiversity Conservation Unit, Reform and Compliance Branch, Environment Protection and Regulation Division) with input and assistance from a wide variety of people.

12 Review Date

This Recovery Plan will be reviewed and updated 5 years from the date of publication.

13 References


Heron, S.J. (1973) Birds of the Orange district, NSW. *Emu* 73, 1-8.


Table 1: Estimated costs of implementing the actions identified in the Bush Stone-curlew recovery plan.

‘In-Kind’ Funds represent salary component of permanent staff and current resources. ‘Cash’ Funds represent the salary component for temporary staff and other costs such as the purchasing of survey equipment. ✓ indicates that costs are likely to be incurred by some Areas of PWD, but there is not enough current knowledge of species distribution or abundance to estimate amounts.

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<th>No.</th>
<th>Action</th>
<th>Priority</th>
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## NSW Recovery Plan

**Bush Stone-curlew Burhinus grallarius**

Table 1 cont’d: Estimated costs of implementing the actions identified in the Bush Stone-curlew recovery plan.

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Table 1 cont’d: Estimated costs of implementing the actions identified in the Bush Stone-curlew recovery plan.

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Table 1 cont’d: Estimated costs of implementing the actions identified in the Bush Stone-curlew recovery plan.

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<td>DPI, research institutions, CMAs, RLPBs, DIPNR, local councils.</td>
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Table 1 cont’d: Estimated costs of implementing the actions identified in the Bush Stone-curlew recovery plan.

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<thead>
<tr>
<th>No.</th>
<th>Action</th>
<th>Priority</th>
<th>Year 1</th>
<th>Year 2</th>
<th>Year 3</th>
<th>Year 4</th>
<th>Year 5</th>
<th>Total (DEC)</th>
<th>EPRD</th>
<th>PWD</th>
<th>Additional funding required</th>
<th>Recommended Implementation Partners</th>
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<td>9.1</td>
<td>Study significance to indigenous Australians</td>
<td>3</td>
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<td>382</td>
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<td>382</td>
<td>-</td>
<td>-</td>
<td>382</td>
<td>10000 Research institutions, Aboriginal groups.</td>
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<tr>
<td>10.1</td>
<td>Integrate RP into other plans.</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
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<td>Source funding for implementation</td>
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<td>1909</td>
<td>1909</td>
<td>9545</td>
<td>9545</td>
<td>-</td>
<td>-</td>
<td>9545</td>
<td>CMAs, local councils, research institutions, NGOs.</td>
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<tr>
<td>11.2</td>
<td>Establish recovery team and interstate working group.</td>
<td>2</td>
<td>382</td>
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<td>382</td>
<td>392</td>
<td>1909</td>
<td>1909</td>
<td>-</td>
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<td>25000</td>
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<td>-</td>
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<td>TOTAL</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td>268,800</td>
<td>882,000</td>
<td>1,150,800</td>
<td>2,785,000</td>
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Appendix 1

a) Local Government Areas with records of the Bush Stone-curlew

Note: Data compiled by DEC from most recently available data held by DEC Atlas of NSW Wildlife records (as at July 2005). Names in *italics* indicate LGAs in which all records are pre-1989. Records from 1989 onwards include the results of specific surveys by NSW Bird Atlassers, the Australian Bird Count and the Birds Australia 2nd Atlas.

This appendix should not be used to discount the presence of the Bush Stone-curlew from LGAs that are not listed below. The list is based on opportunistic records rather than a systematic survey. It is highly likely that the Bush Stone-curlew occurs in additional LGAs.

<table>
<thead>
<tr>
<th>Local Government Area</th>
<th>Local Government Area</th>
<th>Local Government Area</th>
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<tbody>
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<td>Narrabri</td>
</tr>
<tr>
<td>Ashfield</td>
<td>Glen Innes Severn</td>
<td>Narrandra</td>
</tr>
<tr>
<td>Ballina</td>
<td>Gloucester</td>
<td>Newcastle</td>
</tr>
<tr>
<td>Balranald</td>
<td>Gosford</td>
<td>Parkes</td>
</tr>
<tr>
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<td>Penrith</td>
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<td>Greater Hume</td>
<td>Pittwater</td>
</tr>
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<td>Greater Taree</td>
<td>Port Stephens</td>
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<td>Richmond Valley</td>
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<td>Gunnedah</td>
<td>Shoalhaven</td>
</tr>
<tr>
<td>Blacktown</td>
<td>Gwydir</td>
<td>Sydney</td>
</tr>
<tr>
<td>Bland</td>
<td>Hawkesbury</td>
<td>Sutherland</td>
</tr>
<tr>
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<td>Hastings</td>
<td>Tamworth Regional</td>
</tr>
<tr>
<td>Bogan</td>
<td>Hay</td>
<td>Temora</td>
</tr>
<tr>
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<td>Hornsby</td>
<td>Tenterfield</td>
</tr>
<tr>
<td>Brewarrina</td>
<td>Inverell</td>
<td>Tumut</td>
</tr>
<tr>
<td>Byron</td>
<td>Jerilderie</td>
<td>Tweed</td>
</tr>
<tr>
<td>Cabonne</td>
<td>Kempsey</td>
<td>Unincorporated Area</td>
</tr>
<tr>
<td>Campbelltown</td>
<td>Kyogle</td>
<td>Upper Hunter</td>
</tr>
<tr>
<td>Carrathool</td>
<td>Lachlan</td>
<td>Urana</td>
</tr>
<tr>
<td>Central Darling</td>
<td>Lane Cove</td>
<td>Wagga Wagga</td>
</tr>
<tr>
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<td>Leeton</td>
<td>Wakool</td>
</tr>
<tr>
<td>Cobar</td>
<td>Lismore</td>
<td>Walgett</td>
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<td>Lithgow</td>
<td>Warren</td>
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<td>Weddin</td>
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<td>Wellington</td>
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<tr>
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<td>Moree Plains</td>
<td>Wentworth</td>
</tr>
<tr>
<td>Dubbo</td>
<td>Murray</td>
<td>Willooughby</td>
</tr>
<tr>
<td>Dungog</td>
<td>Murrumbidgee</td>
<td>Wingecarribee</td>
</tr>
<tr>
<td>Eurobodalla</td>
<td>Muswellbrook</td>
<td>Wollondilly</td>
</tr>
<tr>
<td>Forbes</td>
<td>Nambucca</td>
<td>Wyong</td>
</tr>
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</table>
b) Catchment Management Areas (CMAs) with records of the Bush Stone-curlew

Note: Data compiled by DEC from most recently available data held DEC Atlas of NSW Wildlife records (as at July 2005).
Priority Areas: H = High, M = Medium, L = Low

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<thead>
<tr>
<th>CMAs with Bush Stone-curlew records</th>
<th>Existing conservation projects</th>
<th>Priority Areas</th>
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<td>M</td>
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<tr>
<td>Central West</td>
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<td>H</td>
</tr>
<tr>
<td>Hawkesbury Nepean</td>
<td></td>
<td>L</td>
</tr>
<tr>
<td>Hunter-Central Rivers</td>
<td>✓</td>
<td>H</td>
</tr>
<tr>
<td>Lachlan</td>
<td>✓</td>
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<tr>
<td>Lower Murray - Darling</td>
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<td>M</td>
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<tr>
<td>Murray</td>
<td>✓</td>
<td>H</td>
</tr>
<tr>
<td>Murrumbidgee</td>
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<td>H</td>
</tr>
<tr>
<td>Namoi</td>
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<td>M</td>
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<tr>
<td>Northern Rivers</td>
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<tr>
<td>Southern Rivers</td>
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<td>L</td>
</tr>
<tr>
<td>Sydney Metropolitan</td>
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<td>L</td>
</tr>
<tr>
<td>Western</td>
<td></td>
<td>L</td>
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</table>

CMAs have been allocated priorities for the implementation of recovery plan actions. Priorities are based on current Bush Stone-curlew records, existing projects (including existing community involvement) and the level of information regarding local populations. These priorities should be reviewed as additional information is obtained.

c) Rural Land Protection Boards (RLPBs) with records of Bush Stone-curlew

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<tr>
<th>Balranald</th>
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<th>Narrandra</th>
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<tbody>
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<td>Hume</td>
<td>Nyngan</td>
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<tr>
<td>Casino</td>
<td>Hunter</td>
<td>Riverina</td>
</tr>
<tr>
<td>Central Tablelands</td>
<td>Kempsey</td>
<td>South Coast</td>
</tr>
<tr>
<td>Cobar</td>
<td>Maitland</td>
<td>Tamworth</td>
</tr>
<tr>
<td>Coonabarabran</td>
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<td>Tweed-Lismore</td>
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<td>Coonamble</td>
<td>Moree</td>
<td>Wagga</td>
</tr>
<tr>
<td>Condobolin</td>
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<td>Walgett</td>
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<td>Dubbo</td>
<td>Mudgee-Merriwa</td>
<td>Wanaarring</td>
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<td>Forbes</td>
<td>Murray</td>
<td>Wentworth</td>
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<td>Gloucester</td>
<td>Narrabri</td>
<td>Willcania</td>
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<tr>
<td>Grafton</td>
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</table>
d) **DEC (Parks and Wildlife Division) and DPI (Forests NSW) Reserves with Bush Stone-curlew records**


*indicates there is a record close to boundary of reserve. “Off-park” indicates records exist within Area but not within DEC estate. *italics* indicates State Forest (SF) (DPI – Forests NSW).

<table>
<thead>
<tr>
<th>DEC PWD Branch</th>
<th>Region</th>
<th>Area</th>
<th>Reserves</th>
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<td>Off-park</td>
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<td>Harbour South</td>
<td>Off-park</td>
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<td>Cumberland South</td>
<td>Off-park</td>
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<td>Cumberland North</td>
<td>Off-park</td>
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<td></td>
<td>Sydney South</td>
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<td>Towra Point NR*</td>
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<tr>
<td></td>
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<td>Illawarra</td>
<td>Thirlmere Lakes NP*</td>
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<td>Dharawal SCA*</td>
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<td>Sydney North</td>
<td>Northern Beaches</td>
<td>Garigal NP*</td>
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### NSW Recovery Plan  
**Bush Stone-curlew* Burhinus grallarius**

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These Habitat Management Guidelines have been developed to assist private and public land managers, and summarises information in the Bush Stone-curlew Recovery Plan. These Guidelines are applicable to private and public lands throughout NSW and will be updated as new information comes to light. Seeking site-specific advice on habitat management from a species expert is also recommended. For more detailed information, please read the full text of the Bush Stone-curlew Recovery Plan.

These Guidelines are not intended for use when assessing Development Applications under the EP&A Act (see Appendix 4 for EIA Guidelines).

What is Bush Stone-curlew habitat?

In general, Bush Stone-curlews are associated with open woodlands with very few shrubs, low, sparse grasses and fallen timber. They can be recorded in agricultural, semi-urban and urban areas if the appropriate habitat exists. The structure of the vegetation, rather than species composition, is important in defining Bush Stone-curlew habitat.

The term ‘Bush Stone-curlew habitat’ refers to breeding, roosting and foraging habitat, each of which have different characteristics. For healthy Bush Stone-curlew populations, all three types of habitat must be available within the home range of adult Bush Stone-curlews.

Breeding sites are often in fairly open areas, with less tree cover, and good visibility for around 100m in most directions. Roosting habitat generally occurs within or around patches of open woodland, with scattered timber and leaf litter on the ground. Foraging habitat occurs where there is an abundance of food (ie invertebrates and small mammals, reptiles and amphibians) and includes woodlands, paddocks, wetlands, mudflats and saltmarsh.

Bush Stone-curlews nest on the ground, and chicks cannot fly until they are approximately 10 weeks of age. Bush Stone-curlews breed from late August through to February.

Habitat Management Considerations

The following factors should be addressed when managing Bush Stone-curlew habitat:

1) Predator Control

Foxes, dogs, cats and pigs need to be controlled within Bush Stone-curlew habitat for the species to survive in the long-term.

1080 baiting programs are recommended in all types of Bush Stone-curlew habitat, particularly breeding habitat. A variety of pest management methods should be used to complement baiting programs, such as shooting and trapping. Shooting and trapping can also be used to control feral cats and dogs. If 1080 baiting is not possible, trapping and shooting programs should be undertaken.

Cattle or sheep which are due to give birth should not be moved into paddocks which are used by Bush Stone-curlews between July and December, as the birthing process will attract foxes. Fox baiting should be undertaken at these times in rural areas. As rabbits may support fox populations, rabbit control may also be undertaken in Bush Stone-curlew habitat.

Rural Lands Protection Boards should be consulted for advice on the most effective methods of predator control. Establishing multi-property pest control programs is likely to be the most effective method of protecting Bush Stone-curlews.

Predator-proof fencing is another method of protecting Bush Stone-curlew habitat, particularly nest sites. This can be successful however there are a number of additional factors which must be considered. See the Guidelines for Fencing in Appendix 3.
2) Retention of Fallen Timber

Retaining fallen timber in Bush Stone-curlew habitat is important as it provides the birds with camouflage against predators and enhances the abundance of invertebrates (food) on the ground. Chicks can hide from aerial predators, such as hawks, under fallen branches which still have dry leaves on them. Simply leaving timber where it falls is the easiest method of retaining fallen timber.

To assist the retention of fallen timber, commercial firewood collection should be prohibited in Bush Stone-curlew habitat. Domestic firewood collection should also be limited, if possible.

If fallen timber has been removed from an area, placing some branches into the area may encourage Bush Stone-curlews to use it. However the branches should be sourced from the same property, if possible, and care should be taken not to introduce weeds. Many landholders 'tidy' paddocks or remove fallen timber prior to cultivating a paddock, and this timber is often burnt. Collect and use this otherwise wasted resource to increase Bush Stone-curlew habitat around woodland patches.

If placing fallen timber into a paddock to encourage Bush Stone-curlews into it, have a look at a site which has Bush Stone-curlews already to assess how much fallen timber is required and how to place it throughout the paddock.

3) Grass length and Groundcover

Bush Stone-curlews need to be able to see approaching predators when they are sitting on the ground. They will leave a site if the grass or groundcover grows too tall and thick. A general rule is to keep grass length below 10-15cm, particularly just prior to and during the breeding season (August to February). Grazing can be used to manage grass length, however stock can trample on eggs. If possible, either protect nesting birds from stock with temporary electric fencing or remove stock from the area just prior to the nesting season.

Herbicides and mowing can also be used to manage grass length, but care should be taken not to disturb nesting birds.

Removing weeds and exotic grasses and replacing them with native grasses enhances Bush Stone-curlew habitat and may reduce the amount of management required over the long term. Weeds, such as Asparagus Fern, and exotic grasses, such as Phalaris, which reduce ground level visibility need to be removed from Bush Stone-curlew habitat.

Sowing cereal crops right up to the edge of small patches of woodland will prevent Bush Stone-curlews from using these areas during the breeding season. As the crop grows, it restricts ground-level visibility and this will make the site unsuitable for breeding by Bush Stone-curlews.

4) Insecticide, Fertilizer and Chemical Use

As Bush Stone-curlews eat insects, including pest species such as locusts, they are likely to consume insecticides applied to them. By applying insecticides, the Bush Stone-curlew’s food resource is also removed and this may result in chicks not consuming enough food to survive. A cautious approach to the use of insecticides in Bush Stone-curlew is recommended until further information is obtained.

For locust control activities, Metarhizium (or Green Guard™) is recommended within a 2km radius of Bush Stone-curlew habitat. It is also recommended that organophosphates and carbamates are not used, if possible. Products containing organochlorides or arsenic should also be avoided.

The use of fertilizers within Bush Stone-curlew habitat should be minimised as much as possible to reduce weeds, exotic grasses or groundcover species growing too tall or thick. Bush Stone-curlews need thin, short and sparse vegetation on the ground.

5) Disturbance

As a general rule, land managers should aim to minimise the level of disturbance from all types of human activity in Bush Stone-curlew habitat. During the breeding season, birds may abandon nests if disturbed frequently by people
or domestic animals. High density stocking rates will cause resident Bush Stone-curlews to move from commonly used roost sites and should be avoided in or around Bush Stone-curlew nesting and roosting habitat.

Activities such as dog walking and children playing should be avoided within approximately 200m of Bush Stone-curlew nest sites. Leash-free dog parks should not be situated within 500m of Bush Stone-curlew habitat.

Erecting a temporary fence around Bush Stone-curlew nests, which does not prevent visibility across the site, may reduce disturbance in areas which are subject to high levels of human activity. However, this technique has only been trialled at a few sites so seek advice from DEC prior to pursuing this option.

Resident pair of curlews will move from their preferred areas when sheep are run at high rates. High density stocking rates should be avoided.

6) Area of habitat

The home range of Bush Stone-curlews is not yet understood, and is likely to vary in different habitats depending on available resources. In general, a breeding pair will require an area of between 10 and 25ha to raise a chick and this must include adequate food supplies (i.e., invertebrates).

Small (less than 1 ha) patches of remnant woodland within a larger cleared area (e.g., paddock or oval) can provide roosting habitat for a pair of Bush Stone-curlews. Several roost sites are usually needed to support a pair of Bush Stone-curlews.

7) Regeneration and Rehabilitation – Habitat for future generations

Ensure that there are areas with young trees growing to provide suitable woodland patches for future generations of Bush Stone-curlews. If there is no natural regeneration occurring on your property, consider planting seedlings. Use tree species that are naturally occurring on your property and source the seedlings locally. Include appropriate grasses and groundcover species in your replanting. Advice should be sought from groups such as Landcare, Greening Australia, local council Bushcare officers, CMA and DEC.

If Bush Stone-curlew numbers increase, more breeding, roosting and foraging habitat will be required to support young birds looking for territories. Managing suitable habitat which does not currently support Bush Stone-curlews provides areas for future generations.

8) Site security and viability

Consider the long-term future of the sites where Bush Stone-curlew occurs and consider providing long-term protection over these areas. Covenants and Voluntary Conservation Agreements can be applied to land to provide for long-term management and protection of the area.

The highest priority for permanent protection and management is public land supporting Bush Stone-curlews, particularly breeding habitat.

9) Hazard Reduction Activities

In Bush Stone-curlew nesting and roosting habitat, hazard reduction activities should take place outside the breeding season i.e., September to February. Areas of habitat containing fallen timber should be maintained as refuges during hazard reduction activities. Surveys for Bush Stone-curlews should be undertaken prior to hazard reduction activities taking place to ensure that birds are protected from equipment and/or fire.

**Broad Landscape Management Recommendations**

- Protect breeding and roosting habitat from predators (fox, dog, cats, etc), human disturbance, and fire.
- Conserve areas of grassy open woodland remnants, wetlands and saltmarsh on public and private land.
- Retain areas of native grassland, particularly if they are surrounding woodland remnants.
- Retain scattered trees in paddocks within areas large enough to collect fallen timber and leaf litter – manage height of grass to keep below 15cm.
• Retain remnant vegetation in roadside reserves, cemeteries, golf courses, along creeklines and paddock boundaries. This will assist to maintain a network of connecting habitat across the landscape.

Further information:


These Guidelines are based on similar guidelines prepared by Kate Stothers, Department of Primary Industries, Victoria in conjunction with a Bush Stone-curlew Taskforce group consisting of officers from the Goulburn Broken Catchment and North-east Catchment of Victoria, Murray Catchment of NSW, and research students from Charles Sturt University, Albury.

Only one part of the picture
Predator-proof fences are only one aspect of property management for Bush Stone-curlew conservation. They should be used in conjunction with other habitat management measures, such as fox-baiting and shooting, management of grass length and retention of fallen timber.

The aim of erecting predator-proof fences is to assist chicks survive to the fledging stage and protect adult birds when breeding. In addition to protected nest sites, dispersing juvenile Bush Stone-curlews also need good quality habitat to occupy. Resource availability, fertility issues, juvenile recruitment to adult stage and predation in general are equally important factors that affect the long-term conservation of Bush Stone-curlews. Unfortunately, fences alone cannot guarantee either a successful breeding event nor the future conservation of viable Bush Stone-curlew populations. However, if managed appropriately fenced areas can provide important refuges and protect significant breeding sites, playing a crucial role in recovering Bush Stone-curlew populations.

The decision to erect predator-proof fences should be assessed on a case-by-case basis taking into account:
- the current threats to and status of the local Bush Stone-curlew population,
- suitability of the site for Bush Stone-curlews – is it known breeding, roosting or foraging habitat?,
- positive and negative impacts on other flora and fauna,
- effectiveness of proposed fence design,
- long-term security of the land tenure,
- commitment of the landholder to the ongoing maintenance of the fence, and
- costs (both to erect the fence and of maintenance).

Priorities for Predator-Proof Fencing
Known Bush Stone-curlew nesting sites are the top priority for predator-proof fencing, particularly if other threatened species on the site will benefit from the fencing. The numbers indicate order of priority.

1. Known nesting locality.
Consistently used nest sites are the top priority for fencing. If it is a known nest site where chicks have previously hatched, there is a greater chance of it being used repeatedly and therefore a higher priority for fencing. If a site has been consistently used for more than 2 years by Bush Stone-curlews, it is reasonably likely that it will continue to be used after fences are erected, as long as the habitat within the fenced area is maintained appropriately (ie manage length of groundcover and retain fallen timber)

Birds should be regularly seen in the proposed location for the fence. Bush Stone-curlews are relatively loyal to sites and will continue to use them over a long period of time. They may however seasonally migrate or move to other locations. Bush Stone-curlews have daytime roost sites (these are where the bird/s are most often seen), night-time foraging sites and nest sites. Fencing day roost sites, areas where the birds are most often seen, will not guarantee they will be used as nest sites.

2. Predator control.
The ability to undertake predator control programs varies between rural and urban areas. In urban areas, domestic pets may be as much as a problem as feral or wild predators. Given these differences, there may be different expectations of landholder responsibilities regarding predator control in rural and urban settings.

a) Rural areas
In rural areas, the landholder should be able to demonstrate they undertake a regular predator control program, incorporating 1080 baiting and shooting. Questions to consider include:
- Does the landholder and/or the neighbouring landholder/s undertake a predator control program?
- How regularly are baits laid and monitored?
As mentioned previously, predator-proof fencing will only protect young from the hatchling to the fledging stage. Adult and juvenile Bush Stone-curlews are still susceptible to predation by predators, such as dogs and foxes. An active fox-baiting program will help reduce this risk of predation when the birds leave the fenced area. Fox baiting is crucial to increasing the numbers of Bush Stone-curlew in the area to maintain viable and growing Bush Stone-curlew populations. Landholders with neighbours who regularly (preferably at least twice a year) undertake a fox-baiting program should be ranked highly when assessing funding applications.

b) Urban areas
In urban areas, the ability of landholders to undertake predator control programs is often limited. Questions to consider when proposing an area for fencing include:

- If fox-baiting or shooting is not possible, is the landholder prepared to work with local agencies to control predators at the site using traps?
- Are domestic pets a problem?
- Is their support from neighbours to keep pets within boundaries?
- Is a local education campaign being conducted to raise awareness of the impact of roaming pets on biodiversity?

In urban areas there are fewer options available to control introduced predators, and domestic pets may pose as much, or more, of a threat to Bush Stone-curlews. In these circumstances, fencing may be considered an option even if baiting cannot occur on the property. Other factors such as long-term maintenance of the fence, public safety, area available to be fenced, effectiveness of the fence design and potential for vandalism/theft will still need to be considered prior to the decision to erect a fence.

3. Landholder’s interest and willingness to participate.
Predator-proof fences often require a significant amount of maintenance to remain effective. If the fence is proposed for a private property, the enthusiasm and commitment of the landholder is crucial for its long-term success. If the fence is proposed for public land, the support and commitment of the agency responsible for management of the land needs to be obtained. Questions to consider include:

- Will the fence be maintained?
- Will the birds be monitored regularly?
- Will the site be managed to maintain low grass cover?
- Will fallen timber be retained on the ground?
- Is the landholder prepared to minimise (or stop altogether) the use of organophosphate and carbamate insecticides within, at least, the fenced area?

Predator-proof fences can be electrified and require relatively high levels of maintenance. The sites need to be grazed or slashed strategically to keep ground cover to less than 15 cm high and fairly thin and sparse. Fallen timber is crucial for camouflage and should be left where it falls. Importantly, the site needs to be monitored to see if the birds are using it. Known breeding events should be reported to DEC, the local council, CMA or person managing the Bush Stone-curlew conservation project.

Fencing Specifications
The specifications for predator-proof fencing will largely depend on the needs of the landholder (for example for stock access), the type of native fauna species present (for example, mesh barriers will be avoided where ground mammals are present), access to materials (for example, mesh types), public safety requirements and updated information from past successful results.

Proposed fence designs should be discussed with a relevant DEC or CMA officer who will provide information on different fencing designs.

Recommended options for predator-proof fencing can be found on the (draft) note *Fox-proof Fencing*, available at DPI Benalla.
Introduction

The Bush Stone-curlew *Burhinus grallarius* is a large, long-legged bird of lowland open woodlands. It is “Endangered” in NSW under the NSW *Threatened Species Conservation Act 1995*.

The Bush Stone-curlew nests and forages on the ground and is easily recognised if observed or heard. However, because of its camouflaged plumage and cryptic behaviour, it often avoids detection.

Description

The Bush Stone-curlew is a medium-sized (800g), ground-dwelling bird that is larger than a lapwing but smaller than an ibis. It has a long neck and legs, a somewhat hunched appearance, rather large, yellow eyes and grey, brown and white plumage. It stands approximately 50-60cm high and is easily recognised, if observed. It is rarely seen flying and runs along the ground or lays flat to avoid detection.

Distribution

All Catchment Management Areas in NSW support Bush Stone-curlews but there is limited knowledge of local distribution and abundance for most areas. It occurs across much of NSW, with the exception of the arid, alpine and rainforest regions (see Figure 1).

Inland of the Great Dividing Range the Bush Stone-curlew occurs to about the 300mm rainfall isohyet, and then becomes more scarce and associated with riverine woodlands.

Abundance

The total NSW population of the Bush Stone-curlew is unknown, although estimates range between a few hundred to a thousand birds. Regional and local abundance is thought to be extremely low across most of the NSW range of the Bush Stone-curlew, with most observations recording single birds or pairs. In NSW, it is unusual to observe more than 4 individuals together. During the non-breeding season, small groups are infrequently observed and mainly during the evening when foraging. These small groups may consist of a single or neighbouring families.

Home Range

Little information is currently known regarding the home range of Bush Stone-curlews in NSW. Breeding pairs are generally sedentary within home ranges estimated to be 250-600ha for foraging year round, with a core of 10-25ha during breeding. Home ranges are likely to be highly variable in size, depending on the type of habitat, resource availability and level of disturbance within the area. At night, birds will travel up to 3km from a roost site to feeding grounds in open paddocks, wetlands, mudflats, reserves, swamps or woodland remnants.

Habitat

Given the broad distribution and variability of the areas supporting Bush Stone-curlews, it is not possible to give a narrow description of the habitat requirements of the species. Many individuals are likely to be recorded in sub-optimal habitat, such as cleared areas, which may provide better chances of survival in the presence of introduced predators.
Bush Stone-curlews are found mainly in lowland grassy woodland and open forest remnants. They appear to exhibit a preference for areas where there is good visibility at ground-level. Areas supporting Bush Stone-curlews usually have short, sparse ground cover, with patches of exposed soil or sand, scattered fallen timber, leaves and sticks. It is this structure which defines Bush Stone-curlew habitat, rather than species composition.

Small (less than 1 ha) patches of remnant woodland within a larger cleared area (eg paddock or oval) can provide roosting or breeding habitat for a pair of Bush Stone-curlews. Maintenance of a short, sparse groundcover with adequate camouflage resources is also essential.

Dominant tree species associated with Bush Stone-curlew habitat west of the Divide include Grey Box *Eucalyptus microcarpa*, River Red Gum *E. camaldulensis*, Black Box *E. largiflorins* and Yellow Box *E. melliodora*, usually with a ground cover of low, sparse native grasses and few or no shrubs, although wattles *Acacia* spp. are occasionally present.

In western NSW, the following vegetation communities are known to support Bush Stone-curlews:

- Box-ironbark forests and patches of she-oaks (*Allocasuarina* spp.);
- the River Red Gum *Eucalyptus camaldulensis* and Black Box *E. largiflorins* woodlands adjoining Boree *Acacia pendula* country;
- the River Red Gum *E. camaldulensis* and Boree *A. pendula* country along the Murrumbidgee River around Darlington Point;
- the grassy woodlands of the Warren – Gilgandra – Coonamble – Gulargambone – Baradine area;
- the remaining grassy woodlands of Moree, Mungindi and Cubberoo;
- Bimble Box woodland and very open Coolibah woodland between Walgett and Collarenebri;
- Poplar Box – Wilga woodland and Baradine Gum-White Cypress woodland in the central west of NSW;
- Bulloak *Allocasuarina luehmannii*, Myall *Acacia pendula*, Box eucalypts and White Cypress Pine *Callitris glaucophylla* in the Grenfell – Caragabal – Forbes area;
- river flat areas, Belah woodland and Belah-Rosewood-mallee vegetation around Buronga and Mildura; and
- mixed Coolibah – Poplar Box – cypress vegetation (i.e. Lightning Ridge Woodlands).

In coastal areas, the Bush Stone-curlew is associated with lowland woodlands and has been recorded in a wide range of vegetation communities including, Swamp Oak *Casuarina glauca* groves, saltmarsh and Paperbark *Melaleuca quinquinervia* woodlands. Birds are also observed within estuarine mangroves during the day, and sometimes standing in the water. Foraging in saltmarshes, mangroves and on mudflats has been observed. Less is known about the habitat of coastal Bush Stone-curlew populations, than those west of the Divide.

**Breeding**

Bush Stone-curlews nests on the ground in a simple scrape or clearing. It has been observed nesting in extremely open areas with very little or no groundcover, often close to a patch of woodland. It relies on camouflage, and is extremely difficult to detect in areas with fallen timber and leaf litter on the ground. When nesting, grass cover must be shorter than approximately 15cm with some patches of bare ground, and sparse, to allow visibility from the nest in all directions. Nest sites are sometimes abandoned if grass becomes too tall or if nesting birds are disturbed frequently. The same nesting sites are often used for a number of years in succession, up to 30 years in one case. The breeding season is usually from mid-August to mid-January, with 2 clutches of eggs laid. Breeding pairs defend territories of 10-25ha, and they may forage over an area of 250-600ha.

Bush Stone-curlew chicks are highly susceptible to predation by introduced animals eg foxes, cats, dogs. Once hatched, chicks are mobile but cannot fly until up to 10 weeks of age. Camouflage is the only defence from predators.
Foraging

The Bush Stone-curlew feeds primarily on invertebrates, although seeds, small fruit, spiders, centipedes, snails, crustaceans, frogs, lizards, snakes and mice may also be included in their diet. They mainly forage at night, probing in leaf litter, fallen timber, rotting wood, soil, and among pebbles and debris.

Bush Stone-curlews have been recorded eating pest species, such as locusts and mice. The consumption of prey which has been subject to pesticides or poisons may adversely affect Bush Stone-curlews, particularly chicks.

Roosting

By day, Bush Stone-curlews shelter on the ground, sometimes close to fallen tree debris, within patches of woodland where they are camouflaged. Daytime roosts are generally less than 1km from other patches of similar habitat. The presence of fallen tree debris and short, sparse grass cover appear to be common features of roost sites. Grass height must be less than 15cm as a lack of understorey provides good visibility.

Threatening Processes

The threatening processes which appear to have caused the decline of the Bush Stone-curlew include the clearing and degradation of native vegetation and the introduction of predators, primarily foxes, cats and dogs.

In addition to these threatening processes, other processes have adversely impacted on the Bush Stone-curlew. These include inappropriate fire regimes, habitat modification, fragmentation and degradation (particularly removal of fallen timber and invasion of the understorey by weeds), expansion of urban areas, inappropriate grazing regimes, intensification of agriculture. Fire and grazing during breeding can disrupt nesting and kill individual birds. Occasional fire and some grazing may be compatible with the maintenance of Bush Stone-curlew habitat.

Within urban areas, Bush Stone-curlews may become accustomed to foraging under street lights that attract insects. This significantly increases the risk of individuals being hit by cars and falling victim to predators.

The application of certain chemicals, eg organochlorides, arsenic compounds, organophosphates and carbamates, is also suspected to have caused declines in Bush Stone-curlew populations and more information is being sought. Insecticides can potentially threaten Bush Stone-curlew populations directly, through ingestion of the chemical and related physiological effects, and indirectly as a result of the loss of foraging resources. Breeding adults and chicks are likely to be more susceptible to the impacts of chemical applications. Bush Stone-curlews consume pest insects, such as locusts, and plagues usually occur during the Bush Stone-curlew breeding season.

Survey Methods

The following survey methods are recommended as best practice for ecological consultants, local government officers, and state government officers undertaking surveys for the purpose of environmental impact assessment (relating to the EP&A Act and the TSC Act).

a) Desktop

Given the difficulty of detecting Bush Stone-curlews in field surveys, recent records from the Atlas of NSW Wildlife, local councils, CMAs, Birds Australia Atlas, bird watching organisations or other reliable sources should be taken as an indication that the species is present within the study area. This assumption is supported by the territorial nature of the Bush Stone-curlew. The presence of suitable habitat within the study area should be taken as an indication that the Bush Stone-curlew may occur given that the absence of records does not discount the possibility of the Bush Stone-curlew being present in an area.

b) Field

A combination of diurnal surveys, spotlighting and call play-back should be conducted at all sites supporting potential foraging, breeding or roosting habitat (Table 1). The effectiveness of survey techniques in detecting Bush Stone-curlews is unknown and it is likely that the species has been poorly considered during environmental impact assessment processes to date.
Surveys for Bush Stone-curlews should be conducted in:

- areas which support potential foraging, breeding or roosting habitat, or
- areas which are known to have supported Bush Stone-curlews historically, or
- areas where Bush Stone-curlews have been previously recorded within 10km of the study area.

Call play-back surveys undertaken during the breeding season could disrupt nesting Bush Stone-curlews, or individuals searching for breeding partners. To minimise disturbance, call play-back surveys should only be undertaken after diurnal searching, listening and spotlighting for birds within the study area. Once an individual is detected, call playback should not be repeated.

Surveys are likely to be most effective just prior to the breeding season or early in the breeding season (August to October) when Bush Stone-curlews begin to increase calling.

Call play-back surveys for Bush Stone-curlews on Kangaroo Island were extremely effective in determining the presence of the species. The majority of responses (89%) were obtained within the first 10 minutes of each survey. However, it is unclear whether call play-back is equally as effective in areas where Bush Stone-curlews are sparsely distributed, such as in NSW, or what percentage of the population responds to call play-back at any particular site.

**Table 1: Field Survey Methods for the Bush Stone-curlew**

<table>
<thead>
<tr>
<th>Method</th>
<th>Suggested Minimum Effort</th>
<th>Survey Period</th>
<th>Considerations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diurnal Survey</td>
<td>Search and listen for Bush Stone-curlews throughout the site. Searches include walking through suitable habitat to flush birds.</td>
<td>All year</td>
<td>Birds will be observed in their daytime roosts or on nests during the day. The Bush Stone-curlew is extremely well camouflaged and very difficult to observe unless it moves.</td>
</tr>
<tr>
<td>Spotting</td>
<td>Spotlight on foot or from a vehicle driven at less than 10km/h across site. Surveyors should listen for calls while spotlighting.</td>
<td>All year</td>
<td>Birds forage at night and so they will often be seen in their foraging habitat rather than roosting or breeding habitat.</td>
</tr>
<tr>
<td>Call playback</td>
<td>Play calls for 30 seconds, followed by 4.5 minutes of listening and spotlighting. Repeat this 5 minute cycle up to 3 times so there is a maximum of 15 minutes survey at each point. Use the same 30 seconds of calls throughout the survey. If a bird responds to the taped call, spend 10 minutes listening for other birds’ responses. Do not play the call again if it is during the breeding season. If birds are calling at a site on arrival, do not undertake call playback. After playing calls, always check the area with a spotlight.</td>
<td>Dusk to early evening. All year. Call play-back surveys are not effective on windy or wet evenings.</td>
<td>Birds are most likely to respond during the breeding season (August to January). To minimise disruption to breeding birds, call play-back is recommended just prior and early in the breeding season. Once a bird has responded to a taped call, cease playing the call to prevent undue stress, particularly if during the breeding season. Bush Stone-curlews may fly towards the taped call rather than call in response.</td>
</tr>
</tbody>
</table>

**Assessing the Impacts of Developments or Activities on Bush Stone-curlews**

The following information should be used when undertaking Assessments of Significance under Section 5A EP&A Act, preparing Species Impact Statements under the TSC Act or environmental planning instruments for biodiversity certification under the TSC Act. It should also be used when assessing the impact of developments or activities on Bush Stone-curlews for any other purpose.
When assessing a development application or other similar activity, Bush Stone-curlews should be considered if a record for the species exists on the study area, or within a 10km radius of the development footprint, unless the study area has become unsuitable for the species since the date of the record. Justification for not considering the Bush Stone-curlew should be given if there is a record of the species on the study area or in the vicinity of the study area (ie within 10km).

All records of Bush Stone-curlews are to be assessed under the assumption that individuals are part of a viable local population. The distribution, abundance and ecology of the species is not understood in the detail required to discount the presence of viable local populations in any parts of NSW where individual Bush Stone-curlews are recorded.

Given the low abundance and sparse distribution of the Bush Stone-curlew within NSW, any recent occurrence of the species is important for its conservation. The loss of individual birds can have a significant adverse effect on local and regional populations and the species as a whole within NSW. Records of isolated single birds are important because they provide information on the species’ distribution and suitable habitat, and indicate that other individuals may be present but undetected.

Breeding habitat is the highest priority for conservation and management. The protection and management of nest sites is a key component of the species’ recovery. The loss or modification of breeding habitat is likely to have a significant adverse impact on a local population of Bush Stone-curlews. The loss or degradation of consistently used Bush Stone-curlew breeding habitat should trigger a Species Impact Statement.

Any impediments to breeding success, particularly disturbance of nest sites during the breeding season and alteration to breeding/nesting sites, may preclude the recovery of the Bush Stone-curlew at a local and regional level. Frequent (ie several times daily) disturbances during the breeding season may cause Bush Stone-curlews to abandon a nest. Constant, low breeding success can have a significant adverse impact on the NSW Bush Stone-curlew population. Breeding habitat can be lost directly or indirectly through the intensification of processes which reduce the likelihood of juvenile recruitment, such as increased levels of disturbance to nesting adults, lack of ability to control predators, increased abundance of predators (including domestic animals).

Bush Stone-curlews require a mosaic of habitats to meet their needs for nesting, roosting and foraging. Disturbance to, or loss of, areas used for any of these activities could render an area unsuitable for Bush Stone-curlews. The incremental loss and degradation of suitable habitat within an area leads to the decline and extinction of local populations. Whether or not an area will provide suitable long-term habitat is dependent on the level of disturbance the birds will face from activities within the area or introduced predators.

Threatening processes to which the Bush Stone-curlew is particularly susceptible include predation by introduced predators (eg foxes, cats, dogs), native vegetation clearance and degradation, removal of fallen timber, invasion of native vegetation by weeds and exotic grasses (eg asparagus fern, phalaris), and fire or grazing regimes which cause adverse changes to habitat or disrupt breeding populations.

Developments or activities which lead to an increase in predators, such as foxes, cats and dogs, are likely to cause local Bush Stone-curlew numbers to decline. Increasing the birds’ exposure to predators, including domestic dogs and cats, will increase direct predation and decrease breeding success and juvenile recruitment.

Vegetation clearance, including the removal of ground litter and fallen timber, can remove habitat or camouflage which may have allowed Bush Stone-curlews to avoid predation.

Human disturbance around breeding sites reduces breeding success. Bush Stone-curlews can abandon their eggs if constantly disturbed while nesting, for example by children playing, dogs and cats roaming around close to the nest.

Home range size is likely to vary in different habitat types and parts of the state (eg western NSW compared to coastal NSW).

Impact Amelioration Measures

Certain proposals are not suitable within Bush Stone-curlew habitat. Proposals which include leash-free dog exercise areas should not be located within 500m of Bush Stone-curlew habitat as free roaming dogs will kill adult and young Bush Stone-curlews.
Pausing development and construction activities within a 200m radius of Bush Stone-curlew breeding sites during the breeding season is considered an ameliorative measure to reduce disturbance to breeding birds.

Proposed urban subdivisions in areas supporting Bush Stone-curlews should include retention of suitable foraging, roosting and nesting habitat, regulations regarding responsible pet ownership (i.e., no leash-free dog areas, strict rules governing pets within properties only), traffic calming devices and street lights which do not attract insects to prevent birds foraging on the streets. Consideration of impacts of resulting bushfire hazard reduction activities must be included.

Golf courses, and similarly vegetated sites, can provide adequate habitat for Bush Stone-curlews in rural areas but a management plan incorporating the requirements of the Bush Stone-curlew should be implemented. In densely populated and urban areas, golf courses are unlikely to provide nesting or roosting habitat because of disturbance from the number and frequency of people walking through the area.

Predator management plans and an undertaking to prepare compliance reports demonstrating regular and appropriate predator control activities should be required as a condition of consent for developments which are likely to attract introduced predators, such as poultry farms and irrigated cereal cropping. In general, these inappropriate developments should be avoided within a minimum of a 2km radius from areas supporting Bush Stone-curlews. Predator control must be frequent and use a number of different methods across a large area.

Fox baiting is not considered an adequate single amelioration method as there is no evidence in eastern Australia that fox numbers can be controlled sufficiently at a regional scale to protect the Bush Stone-curlew. In particular, single property baiting is not adequate and multi-property fox-baiting programs are encouraged.

Habitat creation for known breeding pairs can be included as part of a Development Application but should not be used to compensate for the destruction of known nesting sites. Habitat creation has not been trialled and its level of success is unknown. Similarly, the translocation of individuals will not be approved by DEC if it is being used instead of in situ conservation.

Commercial and domestic firewood collection should be prohibited on public land within areas supporting Bush Stone-curlews. Commercial firewood collection should not be undertaken on private properties supporting Bush Stone-curlews. A precautionary approach to the use of certain agricultural and industrial chemicals is recommended within Bush Stone-curlew habitat. Organochlorides and arsenic compounds are not to be used within areas supporting Bush Stone-curlews. During locust control activities, the DEC recommends that Metarhizium (or Green Guard™) is used in areas within 2km of known Bush Stone-curlew sites, and within Bush Stone-curlew habitat. There is emerging evidence that organophosphates and carbamates can directly, through poisoning, and indirectly, through loss of foraging resources, lead to the decline of Bush Stone-curlew populations.

**BIBLIOGRAPHY**


NSW Recovery Plan  Bush Stone-curlew *Burhinus grallarius*


Appendix 5

COMMONLY USED ORGANOPHOSPHATE AND CARBAMATE INSECTICIDES

The following information is reproduced from “Insect and Mite Control in Field Crops 2003” by Kathi Hertel and Karen Roberts, NSW Agriculture, Orange.

Table 1: Commonly used insecticides which contain organophosphates and carbamate compounds.

<table>
<thead>
<tr>
<th>Product Name</th>
<th>Company Name</th>
<th>Chemical Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dimethoate</td>
<td>Nufarm</td>
<td>Dimethoate</td>
</tr>
<tr>
<td>Nudrin 225</td>
<td>BASF</td>
<td>Methomyl</td>
</tr>
<tr>
<td>Chlorfos</td>
<td>Aventis</td>
<td>Chlorpyrifos</td>
</tr>
<tr>
<td>Lorsban</td>
<td>Dow AgroSciences</td>
<td>Chlorpyrifos</td>
</tr>
<tr>
<td>Rogor</td>
<td>Sipcam Pacific</td>
<td>Dimethoate</td>
</tr>
<tr>
<td>Supracide 400</td>
<td>Syngenta</td>
<td>Methidathion</td>
</tr>
<tr>
<td>Le-mat 290 SL</td>
<td>Bayer</td>
<td>Omethoate</td>
</tr>
<tr>
<td>Aphidex 500 WP</td>
<td>Farmoz</td>
<td>Pirimicarb</td>
</tr>
<tr>
<td>Lannate L</td>
<td>Crop Care</td>
<td>Methomyl</td>
</tr>
<tr>
<td>Carbaryl 500 Flowable</td>
<td>David Gray's</td>
<td>Carbaryl</td>
</tr>
<tr>
<td>Fenitrothion 1000</td>
<td>Nufarm</td>
<td>Fenitrothion</td>
</tr>
<tr>
<td>Imidan</td>
<td>Crop Care</td>
<td>phosmet</td>
</tr>
</tbody>
</table>

During locust control activities, the use of Metarhizium or Green Guard™ is recommended within an area up to 2km from known Bush Stone-curlew sites, and within Bush Stone-curlew habitat.
Appendix 6

Bush Stone-curlew Records in Atlas of NSW Wildlife