

Australasian Bittern
(*Botaurus poiciloptilus*)
Western Australian Recovery Plan



Wildlife Management Program No. # 64

Western Australia

Department of Biodiversity, Conservation and Attractions

August 2018



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Conservation and Attractions

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Western Australia Department of Biodiversity, Conservation and Attractions
Locked Bag 104, Bentley Delivery Centre, Western Australia 6983

Foreword

Recovery plans are developed within the framework provided in Department of Biodiversity, Conservation and Attractions *Corporate Policy Statement No. 35* (Parks and Wildlife, 2015c), and the Australian Government Department of the Environment and Energy *Recovery Planning Compliance Checklist for Legislative and Process Requirements* (DoE, 2014). Recovery plans outline the recovery actions that are needed to urgently address those threatening processes most affecting the ongoing survival of threatened taxa or ecological communities, and begin the recovery process. The attainment of objectives and the provision of funds necessary to implement actions are subject to budgetary and other constraints affecting the parties involved, as well as the need to address other priorities.

This plan will operate for a 10 year period but will remain in force until withdrawn or replaced and will be reviewed at least at five year intervals.

This recovery plan was approved by the Department of Biodiversity, Conservation and Attractions, Western Australia. Approved recovery plans are subject to modification as dictated by new findings, changes in status of the taxon or ecological community, and the completion of recovery actions. Information in this recovery plan was accurate as of August 2018.

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Abbreviations

AOO	Area of Occupancy
ARU	Autonomous Recording Unit
CALM	Department of Conservation and Land Management, Western Australia (changed to DEC July 2006)
CAMBA	China-Australia Migratory Bird Agreement
CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora
CTSSC	Commonwealth Threatened Species Scientific Committee
DBCA	Department of Biodiversity, Conservation and Attractions, Western Australia (formerly Parks and Wildlife)
DEC	Department of Environment and Conservation, Western Australia (formerly CALM, changed to Parks and Wildlife July 2013)
DFES	Department of Fire and Emergency Services, Western Australia
DoEE	Commonwealth Department of the Environment and Energy
DRF	Declared Rare Flora
EOO	Extent of Occurrence
EPBC Act	Commonwealth <i>Environment Protection and Biodiversity Conservation Act 1999</i>
IBRA	Interim Biogeographical Regionalisation for Australia
IUCN	International Union for Conservation of Nature
JAMBA	Japan-Australia Migratory Bird Agreement
NP	National Park
NR	Nature Reserve
NRM	Natural resource management groups
Parks and Wildlife	Department of Parks and Wildlife, Western Australia (formerly DEC, changed to DBCA July 2017)
PEC	Priority Ecological Community
ROKAMBA	Republic of Korea-Australia Migratory Bird Agreement
SF	State Forest
SWALSC	South West Aboriginal Land and Sea Council
TEC	Threatened Ecological Community
UNEP-WCMC	United Nations Environment World Conservation Monitoring Centre
WA	Western Australia
WAM	Western Australian Museum

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Summary

This Recovery Plan applies only to the Western Australian population of Australasian bittern.

Species: *Botaurus poiciloptilus*

Family: Ardeidae

IBRA Regions: Swan Coastal Plain, Jarrah Forest, Warren, Esperance Plains

Department of Biodiversity, Conservation and Attractions Regions: Swan, Wheatbelt, South West, Warren and South Coast

Current conservation status:

- Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act): Endangered
- Western Australia *Wildlife Conservation Act 1950*: Endangered
- New South Wales *Threatened Species Conservation Act 1995*: Endangered
- South Australia *National Parks and Wildlife Act 1972*: Vulnerable
- Victoria *Flora and Fauna Guarantee Act 1988*: Threatened
- New Zealand *NZ Threat Classification System*: Threatened - Nationally Critical

Habitat critical to survival:

In Western Australia, Australasian bitterns feed and breed in generally large, fresh to moderately brackish wetlands with pH levels ranging from 5.5 to 8.5. Extensive areas of water plants, especially rushes, reeds and sedges, provide habitat for the bitterns and support abundant prey (Pickering, 2013). Shallow water, less than 30cm deep with a low to medium density of water plants mixed with, or near short fine sedges are favoured for foraging while higher density emergent vegetation is preferred for nesting (Jaensch, 1982; A. Clarke, pers. comm., 2017).

Threatening processes:

The main threatening processes operating on the Australasian bittern in Western Australia are:

- altered hydrology due to land use changes;
- climate change;
- bushfire and inappropriate fire regimes;
- habitat damage; and
- predation.

Recovery goals and objectives:

The goal of this recovery program is to abate known threats and identify emerging threats to the Australasian bittern in Western Australia, and maintain and enhance wetlands currently or potentially supporting the species to ensure its long-term conservation in the wild.

The species recovery objectives for the next 10 years, are:

1. Characterise and map habitat critical to the survival of the Australasian bittern.
2. Survey and monitor Australasian bittern populations and habitat.
3. Understand ecological requirements to improve conservation and management of the Australasian bittern and its habitat.
4. Protect habitat and manage threats for the long-term survival of the Australasian bittern.
5. Increase community awareness and participation in the conservation of the Australasian bittern.

Criteria for success

The recovery plan will be deemed successful if, within the 10 year life of this plan, the following are achieved:

- Australasian bitterns remain extant at viable important wetland suites¹ in Western Australia; and
- The area and quality of habitat is maintained or increased in the important wetland suites monitored².

Criteria for failure

This recovery plan will be deemed unsuccessful if, within the 10 year life of this plan, either of the following occur:

- Australasian bitterns do not persist in all viable important wetland suites in Western Australia; or
- There is a decline in habitat quality or area of important wetland suites monitored.

¹ Important wetland suites are identified in Section 2. The viability of these wetlands is to be assessed (refer to Section 12.2, Recovery Action 1.4).

² Monitoring undertaken at important wetland suites is listed in Section 9.

1 Introduction

1.1 Description

The Australasian bittern (*Botaurus poiciloptilus*), known to south-west Aboriginal people as boordenitj, is a large, thick-necked heron of stocky appearance, reaching a length of up to 76cm and a wingspan of over one metre. It is cryptic in behaviour, and has mottled and streaked buff, brown and dark brown plumage that makes it difficult to see in the beds of rushes, reeds and sedges it inhabits. Juveniles are much paler than adults. The male's deep resonant booming call is uttered during the breeding season and carries over a kilometre in good weather conditions. Surveys and monitoring largely depend on listening for these calls.

1.2 Conservation status

The Australasian bittern has been listed as specially protected fauna under the Western Australian (WA) *Wildlife Conservation Act 1950* since 1990, and is ranked as Endangered in WA under the Department of Biodiversity, Conservation and Attractions policy using IUCN criteria. This conservation status is consistent with Garnett *et al.* (2011) and the status under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) (DoEE, 2017). The Australasian bittern is also listed as a Threatened species in Victoria, New South Wales, South Australia and New Zealand. It is listed as Endangered on the IUCN Red List. This Recovery Plan only applies to the Western Australian Australasian bittern population.

1.3 Distribution

The Australasian bittern is found primarily in Australia and New Zealand, with outlier occurrences in New Caledonia and Uvea (South Pacific Islands). Within Australia it occurs from south-east Queensland to south-east South Australia, Tasmania and in the south-west of Western Australia (Marchant and Higgins, 1990).

The Australasian bittern was formerly widespread in the south-west of Western Australia, from Moora in the north to Cape Arid in the east. Vagrants have been reported from northern Western Australia, but these are not regarded as resident or breeding occurrences (Johnstone and Storr, 1998). In suitable seasons, Australasian bitterns likely occurred throughout the western and southern Wheatbelt where many wetlands would have provided suitable habitat before widespread clearing for agriculture caused wetland salinisation. The extent to which this impacted the overall distribution and numbers of the Australasian bittern has not been quantified (Pickering *et al.*, 2010).

The current range of the Australasian bittern in the south-west of Western Australia is from Perth in the north-west to east of Esperance in the southeast (Figure 1). The Australasian bittern is distributed patchily in coastal, near coastal and south-west forest wetlands during the breeding season (Pickering, 2013).

Since the 1980s the species has been known only from Forrestdale Lake³, James Swamp and Thomsons Lake in the southern Perth metropolitan area, Benger Swamp near Harvey, Lake Qualeup west of Kojonup, the Muir-Unicup system, and wetlands along the south coast from Augusta east to Cape Arid. The Vasse-Wonnerup system near Busselton provides possibly useful seasonal feeding habitat, where recent surveys have recorded at least one Australasian bittern (Jaensch *et al.*, 2017; Lane *et al.*, 2017a). The Peel-Yalgorup system around Mandurah historically supported the species. Conservation management of Lake Mealup (including *Typha* control) by the Lake Mealup Preservation Society and natural regeneration at Lake McLarty may provide habitat suitable for Australasian bitterns, potentially resulting in their return to this wetland system. The Muir-Unicup system and the south coastal wetlands constitute the current stronghold of the species in Western Australia.

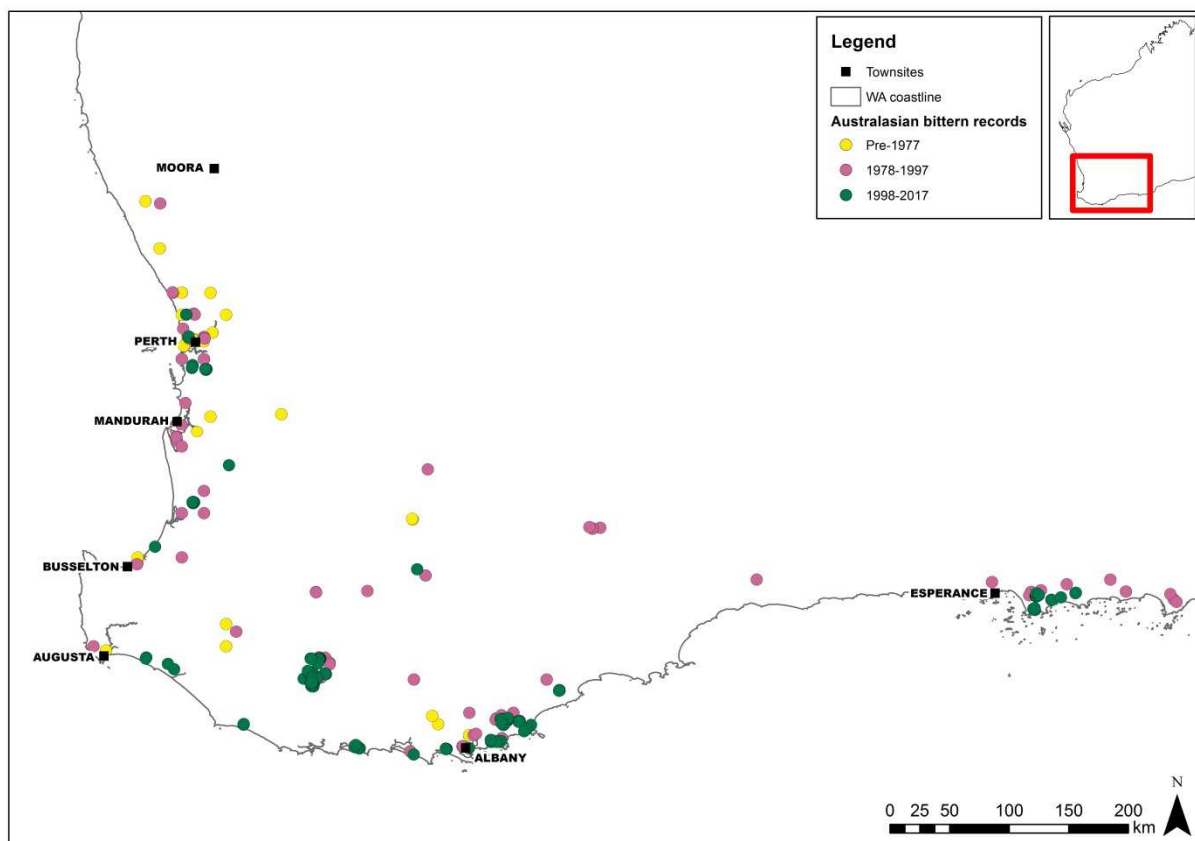


Figure 1: Map of the Australasian bittern’s distribution in the south-west of Western Australia, excluding vagrant, historical records in northern Western Australia (DBCA, 2017).

³ Refer to maps in Appendix 1 for wetlands and locations mentioned in this recovery plan.

1.4 Abundance

The Western Australian population of Australasian bittern is estimated to be <150 mature individuals, based on the most recent 2009/10 population estimates which range from 38 to 154 (Pickering, 2010; Silcocks, 2010). The range and age of this estimate reflects the difficulty in accurately estimating the population in Western Australia. There is a low abundance in WA wetlands due to the population being dispersed over a large area. Even in wetlands with good habitat and food resources there is now rarely more than one pair present.

A comparison with BirdLife data from the 1980s suggests that the Western Australian population declined by 25-50% between the 1980s and 2010, and continues to decline (Pickering, 2010; Pickering *et al.*, 2010). On the Swan Coastal Plain, half of the wetlands that provided habitat for Australasian bitterns in the early 1980s may no longer have suitable habitat for this species (Pickering and Gole, 2008).

The global population is assumed to be less than 2,500 mature individuals (BirdLife International, 2016). This is comprised of 247-796 estimated in Australia (Silcocks, 2010), 580-725 in New Zealand (Heather and Robertson, 2000) (although there is evidence of a reduction in range, and presumably also abundance since that estimate was made (O'Donnell and Robertson, 2016)) and fewer than 50 in New Caledonia and Uvea (Ekstrom *et al.*, 2000). Recently there have been reports of high numbers in artificial wetlands (rice fields) in eastern Australia (Herring *et al.*, 2014).

1.5 Biology and ecology

Breeding

The species' breeding ecology has been poorly studied, but Australasian bitterns are known to nest in vegetation associated with swamps such as *Baumea*, *Gahnia* and *Typha* species, and low bushy shrubs such as *Melaleuca* species (Marchant and Higgins, 1990; Clarke and Wheeler, 2009; O'Donnell, 2011). In Western Australia, nests are built approximately 5-10cm above water, and are a flat platform of approximately 30-40cm in diameter. Nesting material includes broken lengths of *Baumea*, *Typha* or sticks, often with fine sedge woven through, although nests located in recent years have been constructed solely from sedges (Johnstone and Storr, 1998; Clarke and Wheeler, 2009; A. Clarke, pers. comm., 2012).

In order to attract a mate, the male bittern will make a booming call, and it is believed that it only booms if the environmental conditions are suitable for a breeding attempt (A. Silcocks, pers. comm., 2009). Evidence from the Muir-Unicup system indicates that males commence calling once wetland water levels have peaked (R. Hearn, pers. comm., 2012). This usually occurs from September to December in southern WA, with a peak calling period in October and November (Pickering, 2013). Unseasonal rainfall and other hydrological factors can result in the breeding season occurring later (Jaensch *et al.*, 2009).

It is thought bitterns call to advertise their presence to mates and to defend territory (Marchant and Higgins, 1990; Cramp and Simmons, 1977). Typically, an Australasian bittern call consists of up to four gasps, followed by a 'woomph', then gasp, then a 'woom' more resonant and longer than the first boom, usually repeated 2-3 times (Marchant and Higgins, 1990). Sometimes very short calls can be heard which consist of one 'oom'. These are thought to be warning or 'warm-up' calls (Pickering, 2013).

Clutch size in Western Australia is 4-5 eggs, usually laid from September to December (Johnstone and Storr, 1998). Incubation and fledging periods are unknown, but are likely to be similar to that of the Eurasian bittern (*Botaurus stellaris*) (26 days and 55 days respectively) (Cramp and Simmons, 1977; Puglisi and Bretagnolle, 2005). It is assumed that only the female incubates the eggs and rears the young, as in the Eurasian bittern. For the Eurasian bittern, only having one parent caring for the young can have an impact on successful rearing if suitable food supplies are not available. Not only is there less food for the chicks, but the female will spend longer away from the nest foraging, leaving the young exposed to predation (Gilbert *et al.*, 2007). A similar situation appears likely for the Australasian bittern.

In Western Australia the Australasian bittern is usually found singly and occasionally in pairs. During the breeding season few wetlands support more than one pair but, when conditions are good, higher densities may be found even during the breeding period. At one medium sized wetland east of Esperance at least five males were heard calling in October 2011 (Pickering, 2012).

Seasonal movements

Australasian bitterns are probably sedentary in permanent habitat but there may be regular dispersal of young birds, short distance movements during winter and occasional irruptions associated with wet years. In Western Australia, many wetlands where Australasian bitterns are found are semi-permanent and it is thought that some individuals may fly to estuaries and south coastal drought refuges in late summer until mid-winter (Pickering, 2013). Data from Hardy Inlet suggest late summer/early autumn use of estuarine/river habitat, consistent with the notion of seasonal movements to drought refuge areas (Lane, 1976). Significant mobility is suggested by two specimen records, one from the extreme north-east of Western Australia in 1971 and another from Shark Bay in 1912 (Marchant and Higgins, 1990; Johnstone and Storr, 1998). More recently, satellite tracking of birds in eastern Australia has shown that outside of the breeding season Australasian bittern will travel large distances, up to 600km, between otherwise disparate wetlands (Herring *et al.*, 2016).

Australasian bitterns are often found in small groups during late summer to early winter when semi-permanent wetlands are dry and permanent wetlands contain less water (Marchant and Higgins, 1990; Teale, 1989). For example, during autumn surveys at Lake Pleasant View in 2011 and 2012, 8-10 Australasian bitterns were found within a small part of the wetland where water remained, whereas during the spring breeding season this wetland appeared to support only one or two pairs (A. Clarke, pers. comm., 2012).

Longevity

The generation time for the Australasian bittern has been estimated at 5.5 years on the following basis. The Eurasian bittern (*Botaurus stellaris*) has a mean age at first breeding of two years (Cramp and Simmons, 1977) and a maximum longevity in the wild of 11.3 years (del Hoyo *et al.*, 1992) while the American bittern (*B. lentiginosus*) has a maximum longevity of 8.3 years (del Hoyo *et al.*, 1992). Extrapolating these values to the Australasian bittern and using an extrapolated mean annual survival of 68% based on other heron genera, the estimated generation length is 5.5 years (BirdLife International, 2017).

Diet

The Australasian bittern is carnivorous, feeding on a variety of small to medium sized prey, including fish, invertebrates, frogs, mice, small birds and small reptiles (Clarke and Wheeler, 2009; Marchant and Higgins, 1990; Teale, 1989).

2 Habitat critical to survival

All wetlands in which the Australasian bittern is known to breed and/or which it habitually occupies, and areas that support the hydrology of the wetland, are critical to its survival. These include:

- the suite of wetlands occupied by Australasian bitterns (where occupancy is defined as regularly supporting at least one pair in years in which conditions are suitable);
- areas of similar habitat adjacent to these wetlands (providing potential habitat for population expansion);
- the local catchment for the surface and/or groundwater that maintains these wetland habitats; and
- suitable wetland habitat that may contain undiscovered populations of the species or be suitable for future occupation.

The most important wetland suites in Western Australia are:

- the Muir-Unicup system;
- Lake Pleasant View/Mt Manypeaks wetlands; and
- Cape le Grand wetlands.

The other important wetland suites include:

- Benger Swamp;
- the Vasse-Wonnerup system;
- Gingilup/Quitcup/Jasper wetlands (Gingilup-Jasper system);
- Lake Maringup;
- Boat Harbour/Owingup wetlands; and
- Moates Lake suite.

Wetland suites that include freshwater wetlands dominated by *Baumea articulata* and low fine sedge in shallow water, such as the Bremer and Mettler wetlands, may also be of value. Hereafter, all of the above areas are defined as, and referred to as ‘important wetland suites’ in this plan (Figure 2).

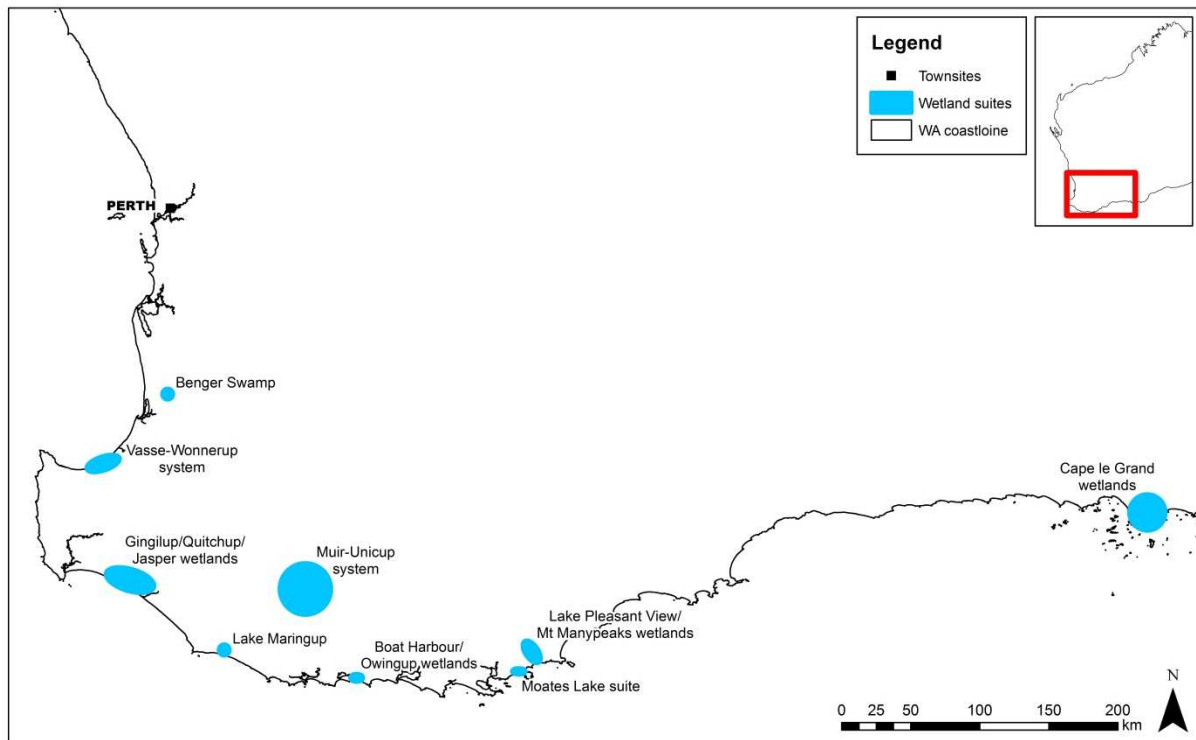


Figure 2: Map of the generalised areas of the important wetland suites for the Australasian bittern in the south-west of Western Australia (DBCA, 2018).

3 Threatening processes

3.1 Altered hydrology due to land use changes

Australian wetlands utilised by Australasian bitterns have declined in area and/or quality in every State in the last 10 years largely due to land use changes, and this decline is continuing (Buchanan, 2009).

In Western Australia, perhaps the most dramatic land use change was the broad scale clearing of the south-western agricultural area throughout the first two thirds of the twentieth century. This extensive clearing resulted in hydrological changes and secondary salinisation of wetlands, waterways and dryland areas (DEC, 2012; Halse *et al.*, 2003). The southern and western areas of the cleared land supported wetlands known, or suspected to have been suitable for the Australasian bittern.

WA wetlands, including some within the important Muir-Unicup system, continue to be affected by salinisation and/or acidification (Sommer and Horwitz, 2001; Lane *et al.*, 2017b; Pickering, 2013), and some of these have recently lost bittern populations (Clarke *et al.*, 2011). For example, Lake Cobertup and Yarnup Lagoon in the Muir-Unicup system used to support Australasian bittern but are no longer considered suitable because of a complete loss of habitat due to acidification and secondary salinisation (Lane *et al.*, 2016a; R. Hearn, pers. comm., 2012).

Other land use changes that adversely affect wetlands continue to occur (Halse *et al.*, 2003). Urban and peri-urban drainage either reduces inflow and water depth, or overfills wetlands, so that the vegetation that provides habitat for Australasian bitterns is adversely impacted (DEC, 2012; Lane *et al.*, 2016a). A number of south coast and Muir-Unicup wetlands were affected by widespread tree farming, which reduced inflow to wetlands while the trees were growing and caused excessive runoff and sedimentation during harvesting (Wallace *et al.*, 2011). Recent land use changes in these areas have included the removal of many of the plantations, which are unlikely to be replaced. Removing the plantations will likely lead to increased ground and surface water flows, and potentially increased salinity (I. Wilson, pers. comm., 2017).

Australasian bittern, due to their mobility, appear to be able to adapt to the short-term and seasonal changes in the local availability and suitability of ephemeral wetlands. However, they are likely to be particularly sensitive to any long-term and permanent changes to ephemeral wetlands and to the destruction of permanent wetlands (Garnett and Crowley, 2000). Loss of these drought refugia may explain the species decline in Western and South Australia (Garnett, 1992).

3.2 Climate change

There is strong evidence that rising global temperatures due to the enhanced greenhouse effect have a substantial impact on southern Australian water resources. In south-western WA, the well-documented decline in rainfall in recent decades has impacted water levels in wetlands and some wetlands have changed from permanent to semi-permanent (DEC, 2012; Lane *et al.*, 2015). The increase in fire associated with drier and warmer climates is also of concern (Hughes and Steffen, 2013). These factors will further reduce the area of suitable habitat for the Australasian bittern and increase the importance of wetlands that act as drought refugia.

3.3 Bushfire and inappropriate fire regimes

Intense and frequent bushfires or prescribed burning in wetlands reduces the density and cover of vegetation that forms the core habitat of the Australasian bittern. Past bushfires and prescribed burns that have burnt wetlands are known to have been detrimental to the species (CTSSC, 2011b; Pickering, 2013).

A drying climate and the associated hydrological impacts, exacerbate both the frequency of fires in wetlands and the long-term impact of fire on such wetlands (Hughes and Steffen, 2013). In terms of frequency, dry wetlands burn more readily, and the window of opportunity is longer for both deliberately lit fires and for bushfire. In terms of long-term impacts, the intensity of burning and destruction of peat substrata increases as wetlands dry, and wetland recovery to a state suitable for bitterns is likely to be much longer (Horwitz and Smith, 2005). For example, the *Baumea* habitats favoured by Australasian bitterns have been observed to take over a decade to recover from fire (R. Hearn, pers. comm., 2012; S. Comer, pers. comm., 2012).

Individual wetlands may require different fire regimes depending on vegetation type and geographical location. Without occasional fire, rushes or sedges (especially the rush *Typha orientalis*) may become too dense for the movement of bitterns through them (A. Clarke, pers. comm., 2017).

3.4 Habitat damage

The Australasian bittern is highly sensitive to habitat loss and damage as it has relatively specialised habitat requirements, preferring wetlands with moderately dense vegetation (Marchant and Higgins, 1990; Pickering, 2013).

Historically, vegetation clearing and the modification of wetlands (e.g. filling) has damaged large areas of habitat, particularly on the Swan Coastal Plain (Riggert, 1966). The diversion of water away from wetlands, salinisation (particularly in the Wheatbelt), and groundwater abstraction also alter wetland habitats that support various waterbirds including bitterns (Halse *et al.*, 2003; Pickering, 2013).

Wetlands dominated by the invasive *Typha* have had lower densities of bitterns recorded calling compared to wetlands dominated by *Baumea* sedges (Pickering, 2013). Expansion of *Typha* has contributed to major detrimental changes in wetlands known to support Australasian bittern (Lane *et al.*, 2016a). Weeds, including blackberry (*Rubus* spp.) and Sydney golden wattle (*Acacia longifolia*), can be problematic where they encroach into foraging habitat.

Feral and domestic herbivores and omnivores (cattle, horses, deer, goats and pigs) can, through grazing and trampling, directly damage nests, reduce foraging habitat and reduce cover from predators.

3.5 Predation

Introduced predators, especially foxes, and (perhaps to a lesser extent) feral cats, rats and pigs, are widespread throughout the range of the Australasian bittern in Australia. The nests of Australasian bitterns are built in moderately dense vegetation in shallow water, and therefore both eggs and young birds may be vulnerable to these predators. The level of impact that predation has on the species is unknown, but considering the small population size in WA (<150 mature individuals), any predation would likely be significant (R. Pickering, pers. comm., 2017).

Predation by native fauna, including swamp harriers (*Circus approximans*), rakali/water-rats (*Hydromys chrysogaster*) and bush rats (*Rattus fuscipes*), is also known to occur. Snakes and Australian ravens (*Corvus coronoides*) may also predate on Australasian bittern eggs or fledglings (Pickering, 2013). Where alterations to habitat have shifted the ecological balance between these species, predation from native fauna may be a threat to Australasian bitterns.

4 International obligations

This plan is consistent with the aims and recommendations of the Convention on Biological Diversity, ratified by Australia in June 1993, and it will assist in implementing Australia's responsibilities under that convention. Several of the wetlands that support Australasian bitterns are internationally recognised under the Ramsar Convention on Wetlands. These include the Muir Unicup system, Forrestdale and Thomsons Lakes, a component of the Peel-Yalgorup system and the Vasse-Wonnerup system.

The species is not listed under the appendices to the United Nations Environment World Conservation Monitoring Centre's (UNEP-WCMC) Convention on International Trade in Endangered Species (CITES). While the Australasian bittern is not listed under international migratory bird agreements such as CAMBA, JAMBA and ROKAMBA, it co-habits many wetlands which provide habitat for listed migratory waders.

5 Affected interests

The stakeholders potentially affected by the implementation of this plan include all managers of land containing wetlands and their catchments regularly supporting Australasian bitterns or supporting Australasian bitterns at critical times (e.g. during severe drought). Thus there may be many interests potentially affected by this recovery plan. In most cases impact upon current land use is unlikely; however, to achieve the objectives of this plan there may be an effect on landowners who may wish to further develop their land or change their land

management practices. Landholders and land management agencies may thus be affected through statutory planning and approval processes, when seeking to alter the landscape or undertake actions that may cause any of the resulting effects to the Australasian bittern as outlined in Section 11 Guide for Decision-Makers. Where populations occur on lands other than those managed by DBCA, permission has been or will be sought from the managers before recovery actions are undertaken on their land.

Interests potentially affected by, or involved in the implementation of this recovery plan include:

- Private and commercial land owners and managers;
- Local government authorities;
- Non-government organisations;
- Government departments and agencies (e.g. DBCA; Department of Planning, Lands and Heritage; WA Planning Commission; Department of Water and Environmental Regulation; Environmental Protection Authority; Department of Mines, Industry Regulation and Safety; and the Commonwealth Department of the Environment and Energy);
- Traditional owners and managers (e.g. South West Aboriginal Land and Sea Council (SWALSC)); and
- Development and infrastructure providers.

6 Role and interests of Aboriginal people

The Australasian bittern is known to south-west Aboriginal people as boordenitj, but details of the significance of the species to Aboriginal people in this area is not documented. DBCA will consult with Aboriginal communities in the regions identified in this plan and ensure consideration of their role and interests in the implementation of this plan. Input and involvement will be welcome from any Aboriginal groups that have an active interest in areas in which the Australasian bittern occurs, and their involvement in recovery team representation will be sought. The Aboriginal Sites Register, maintained by the Department of Planning, Lands and Heritage, will be used to identify significant sites near these wetlands. However, not all significant sites are listed on the register, and on-going liaison will be maintained with local Aboriginal community representatives to ensure appropriate input to proposed recovery actions.

SWALSC, an Aboriginal umbrella group, covers the areas considered in this plan. Comment was sought from the council about aspects of the plan, particularly about the proposed on-ground actions.

DBCA has met with traditional owners of the Lake Pleasant View property which abuts Lake Pleasant View Nature Reserve, and discussed wetland management and conservation of the Australasian bittern habitat. Communication and education programs coordinated by South Coast NRM with both elders and youth have been undertaken in this area.

The *Conservation and Land Management Act 1984* and the *Wildlife Conservation Act 1950* provide rights for Aboriginal people to undertake certain activities for customary purposes. They recognise the special connection Aboriginal people have to the land and the existence, or otherwise, of native title rights.

7 Social and economic interests

The implementation of this recovery plan has the potential to have social or economic impacts through the identification and recommendation to protect significant habitat. Australasian bitterns occur in wetlands both in and adjacent to private property. Some proponents of particular land uses, for example agriculture, mineral extraction and urban or industrial land development, may need to demonstrate through statutory processes that proposals will not significantly impact on Australasian bitterns or that any impacts can be adequately mitigated. Such requirements would be in place irrespective of this plan, and this plan will provide direction for the implementation of such measures.

Control of introduced predators may have a social impact if pets ingest toxic baits that have been laid for species protection. However, DBCA risk management strategies, including media releases warning the public of the risk that baits pose to domestic animals and signage denoting baited areas, are undertaken as a part of the department's baiting programs.

8 Broader biodiversity benefits

Recovery actions implemented to improve the quality or security of the habitat of Australasian bitterns will also improve the status of relevant wetland communities and associated native vegetation and native fauna.

The Australasian bittern has been recorded in recent decades in the following Ramsar wetlands (wetlands of international importance): Forrestdale and Thomsons Lakes, Muir-Unicup system (part of the Muir-Unicup system), Peel-Yalgorup system, and Vasse-Wonnerup system. Management of these wetland suites for the benefit of the Australasian bittern will enhance their values. There is an historical record for the Australasian bittern in Lake Toolibin, a Ramsar wetland in the Wheatbelt, but the habitat at this site is no longer suitable to support this species. The Lake Gore, Lake Warden system and Becher Point Ramsar wetlands are within the species distribution but there are no records of Australasian bittern at these sites.

Recovery actions may be of benefit to the native threatened fauna species that occur in the same habitat as Australasian bitterns. The Australian painted snipe (*Rostratula australis*) (Endangered), Curlew sandpiper (*Calidris ferruginea*) (Vulnerable), noisy scrub-bird (*Atrichornis clamosus*) (Endangered), Carter's freshwater mussel (*Westralunio carteri*) (Vulnerable), mud minnow (*Galaxiella munda*) (Vulnerable), black-striped minnow (*Galaxiella nigrostriata*) (Endangered), western trout minnow (*Galaxias truttaceus hesperius*) (Endangered) and Balston's pygmy perch (*Nannatherina balstoni*) (Vulnerable) are either known from or may occur in areas used by bittern (R. Hearn, pers. comm., 2012). Various migratory birds protected under international agreements also occur in wetlands where Australasian bittern have been recorded.

Recovery actions may also potentially be of benefit to various priority flora and the following declared rare flora (DRF) have been recorded in wetland areas that Australasian bittern occur in: *Austrostipa jacobiana*, Christine's spider orchid (*Caladenia christineae*), Harrington's spider orchid (*Caladenia harringtoniae*), grand spider orchid (*Caladenia huegelii*), tall donkey orchid (*Diuris drummondii*), glossy-leafed hammer orchid (*Diuris elastica*), dwarf bee orchid (*Diuris micrantha*), Purdie's donkey orchid (*Diuris purdiei*), *Eucalyptus insularis continentalis*, prickly honeysuckle (*Lambertia echinata* subsp. *echinata*), beaked *Lepidosperma* (*Lepidosperma rostratum*), remote thorny lignum (*Muehlenbeckia horrida* subsp. *abdita*), Selenia's *Synaphea* (*Synaphea* sp. Fairbridge Farm), and Dwellingup *Synaphea* (*Synaphea stenoloba*).

The recovery actions for the Australasian bittern may also potentially benefit some priority ecological communities (PECs) and the following threatened ecological communities (TECs):

- Shrublands and woodlands on Muchea Limestone;
- *Corymbia calophylla-Eucalyptus marginata* woodlands on sandy clay soils of the southern Swan Coastal Plain;
- Shrublands on calcareous silts of the Swan Coastal Plain;
- Forests and woodlands of deep seasonal wetlands of the Swan Coastal Plain;
- Stromatolite-like freshwater microbialite community of coastal brackish lakes; and
- Scott River Ironstone Association.

The distribution of this species also overlaps with the following EPBC Act-listed threatened ecological communities:

- Several components of the Clay Pans of the Swan Coastal Plain;
- Subtropical and Temperate Coastal Saltmarsh; and
- Proteaceae Dominated Kwongan Shrublands of the Southeast Coastal Floristic Province of Western Australia.

Locations of threatened and priority fauna, DRFs and priority flora, and TECs and PECs should be sought prior to undertaking recovery actions which have the potential to disturb native vegetation.

9 Previous and existing conservation and management actions

The following actions have been, or are currently being implemented, to support the conservation and recovery of the Australasian bittern.

- Surveys to ascertain the distribution of the species and estimate population numbers in Western Australia have been undertaken by DBCA and BirdLife WA since 2007 (Lane *et al.*, 2017a; Lane *et al.*, 2016a; Pickering, 2013; Pickering *et al.*, 2015; Pickering, 2017).
- Documentation and assessment of habitat and wetland characteristics (vegetation and water chemistry) of wetlands known to support Australasian bitterns in Western Australia have been undertaken collaboratively and individually by DBCA and BirdLife WA and other researchers (BirdLife Australia, 2015; Jaensch and Vervest, 1988; Lane *et al.*, 2017b; Lane *et al.*, 2016a; Pickering, 2013; Pickering *et al.*, 2015).
- Physicochemical characteristics have been monitored at a range of wetlands across south-western WA, and some of these wetlands are known to support, or previously supported Australasian bitterns (Lane *et al.*, 2017b; Lane *et al.*, 2016b).
- DBCA staff have monitored Australasian bittern at various wetlands across the south-west of WA. Visual surveys are undertaken to locate Australasian bittern nests and characterise breeding habitat, and autonomous recording units are deployed to monitor bittern usage of wetlands.
- An Honours research study investigated the vocalisation and vocal individuality of Australasian bitterns in some Western Australia wetlands (Graff, 2014). It was determined that it may be possible to track individual bitterns from year to year and determine biological information such as wetland fidelity, seasonal movements and regularity of potential breeding periods; however, there remains significant practical challenges to achieve this.
- DBCA have surveyed and continue to monitor a range of wetlands across WA to provide early warnings of hydrological changes and to investigate responses of wetland fauna and flora to threatening processes (Lane *et al.*, 2017b, 2016b). Water levels and rainfall at known and suspected key sites for the Australasian bittern, such as Gingilup/Quitcup/Jasper wetlands, Lake Maringup, Lake Pleasant View/Mt Many peaks wetlands, Cheynes Swamp, and the Cape le Grand wetland Big Boom Swamp, have been monitored continuously since 2010–2012 (Lane *et al.* 2016b). These data in particular will enable modelling and prediction of likely hydrological futures and consequences of ongoing climate change, particularly rainfall decline, for Australasian bitterns.

- DBCA has undertaken fox baiting and feral pig control at Benger Swamp Nature Reserve which was increased/expanded specifically to protect Australasian bittern, their habitat and potential breeding locations.
- DBCA and community groups have undertaken woody weed removal at some wetlands providing habitat for Australasian bittern. The Sydney golden wattle (*Acacia longifolia*) has been the target of weed removal programs in Australasian bittern wetlands in the Albany area.
- Management plans under the CALM Act have been prepared for the following areas incorporating wetlands where Australasian bitterns have been recorded: Benger Swamp Nature Reserve (CALM, 1987), Forrestdale Lake Nature Reserve (CALM, 2005a), Thomsons Lake Nature Reserve (CALM, 2005b), Lake McLarty Nature Reserve (DEC, 2008c), Two People's Bay Nature Reserve (Gardner, Moates and Angove Lakes) (CALM 1995), Shannon and D'Entrecasteaux National Parks (DEC 2012), Perup (DEC 2012), Esperance Lakes Nature Reserve (Shark Lake) (Parks and Wildlife, 2016b) and Swan Coastal Plain South (Parks and Wildlife, 2016c).
- Over a 40 year period, DBCA acquired the entire Benger Swamp for inclusion in the Benger Swamp Nature Reserve (Errington and Moore, 2010), with management of the reserve focusing on rehabilitation and protection of Australasian bittern and other waterbird habitat (CALM, 1987).
- New water control structures were built at Benger Swamp Nature Reserve to allow water levels to be managed to maximise benefit to breeding waterbird species including bitterns.
- The Lake Muir-Unicup system catchment is managed by DBCA. A review of management actions under the natural diversity recovery catchment program is provided in Wallace *et al.* (2011).
- DBCA has commenced the process of including unallocated crown land north of Cape Le Grand National Park into the national park, as several wetlands in this area support significant numbers of Australasian bitterns (Parks and Wildlife, 2016b).
- BirdLife WA trained and engaged volunteers to undertake surveys for Australasian bittern in the south-west, as part of a project undertaken jointly by DBCA and BirdLife WA (Pickering, 2013). The project contributed to awareness raising in a number of ways, including the publication of articles and brochures, and presentations at conferences and other events. This work continues at some wetlands in the south-west, although it is not undertaken systematically.
- A national bittern database has been established by BirdLife Australia. The occurrence records are input into the Bird Atlas and are then available through the department's and WAM's online mapping tool, NatureMap.
- BirdLife Australia has established a bittern webpage on the organisation's website which includes information on the status of the species, identification kits and survey techniques.

- South Coast NRM and DBCA South Coast and Warren Regions conducted targeted threat abatement activities, including weed and pest management and disease control, for various threatened species including the Australasian bittern (SCNRM, 2017).
- The Lake Muir/Denbarker Community Feral Pig Eradication Group implemented educational and on-ground works to eradicate feral pigs in the Lake Muir-Denbarker area between 2001-2012, with additional work undertaken by the South Coast NRM between 2012-2016 (Green Skills, 2013; SCNRM, 2017).
- The Blackwood Basin Group undertook a four-year *Priority Bittern and Waterbird Biodiversity Enhancement Project*, in partnership with Talison Lithium Pty Ltd, to revegetate and undertake weed and pest control at the historical Schwenkes mining pit to create suitable habitat for waterbirds (BBG, 2015).
- With funding from the Western Australia Government State NRM Program, the Blackwood Basin Group rehabilitated Lake Qualeup and surrounding low-lying areas in 2013-14 with the aim of improving habitat for the Australasian bittern and other waterbird species (NRM Program, 2017).

Table 1 summarises current monitoring undertaken in the important wetland suites.

Table 1: Monitoring of the important wetland suites in Western Australia

Name of wetland suite	Monitoring undertaken within wetland suite
Muir-Unicup system	<p><i>Targeted Australasian bittern surveys:</i> Autonomous recording units (ARUs) (acoustic monitoring) currently deployed.</p> <p><i>Wetland hydrology:</i> Biannual water level, salinity and pH monitoring currently undertaken at several wetlands within the suite (Lane <i>et al.</i>, 2017b).</p>
Lake Pleasant View/Mt Manypeaks wetlands	<p><i>Targeted Australasian bittern surveys:</i> Annual spring listening surveys (acoustic monitoring) currently undertaken. Annual spring wading surveys also undertaken to flush individual birds and conduct habitat and breeding assessments. Remote cameras deployed to gather life history information.</p> <p><i>Wetland hydrology:</i> Continuous water level and rainfall monitoring using automated depth loggers and rain gauges currently undertaken at Lake Pleasant View, North Sister and Cheynes Swamps (Lane <i>et al.</i>, 2016b).</p>
Cape le Grand wetlands	<p><i>Targeted Australasian bittern surveys:</i> Spring-summer surveys (acoustic monitoring) currently undertaken.</p> <p><i>Wetland hydrology:</i> Continuous water level and rainfall monitoring using automated depth loggers and rain gauges currently undertaken at Big Boom Swamp (Lane <i>et al.</i>, 2016b).</p>

Name of wetland suite	Monitoring undertaken within wetland suite
Benger Swamp	<p><i>Targeted Australasian bittern surveys:</i> Annual listening and call playback surveys (acoustic monitoring) currently undertaken during the breeding season. ARUs are deployed for additional acoustic monitoring. Diurnal wading surveys also undertaken to flush individual birds.</p> <p><i>Potential Australasian bittern habitat:</i> Additional ARUs and remote cameras have been deployed in potential Australasian bittern habitat near Benger Swamp to determine species presence.</p>
Vasse-Wonnerup system	<p><i>Targeted Australasian bittern surveys:</i> Following a sighting in spring 2016, remote cameras were deployed.</p> <p><i>Waterbird surveys:</i> Monthly waterbird census/count surveys currently undertaken (Lane <i>et al.</i>, 2017a).</p> <p><i>Wetland hydrology:</i> Continuous water level and rainfall monitoring using automated depth loggers and rain gauges currently undertaken (Lane <i>et al.</i>, 2017b).</p>
Gingilup/Quitcup/Jasper wetlands	<p><i>Targeted Australasian bittern surveys:</i> Surveys were previously undertaken at Lake Jasper in the 1990s. A remote camera is currently deployed at Gingilup Swamps.</p> <p><i>Wetland hydrology:</i> Continuous water level and rainfall monitoring using automated depth loggers and rain gauges currently undertaken at Gingilup Swamps (Lane <i>et al.</i>, 2016b).</p>
Lake Maringup	<p><i>Opportunistic surveys:</i> <i>Ad hoc</i> surveys are conducted when conditions are suitable.</p> <p><i>Wetland hydrology:</i> Continuous water level and rainfall monitoring using automated depth loggers and rain gauges currently undertaken (Lane <i>et al.</i>, 2016b).</p>
Boat Harbour/Owingup wetlands	<p><i>Opportunistic surveys:</i> <i>Ad hoc</i> surveys are conducted when conditions are suitable.</p> <p><i>Targeted Australasian bittern surveys:</i> Spring 2017 listening (acoustic monitoring) and wading surveys undertaken. Comprehensive surveys were also undertaken in 2008-2010 (Lane <i>et al.</i>, 2016a).</p>
Moates Lake suite	<p><i>Targeted Australasian bittern surveys:</i> Surveys (acoustic monitoring) undertaken in 2016.</p> <p><i>Wetland hydrology:</i> Biannual water level, salinity and pH monitoring currently undertaken (Lane <i>et al.</i>, 2017b).</p>

10 Management practices and policies

Management practices (policies, strategies, plans) that have a role in the protection of the species include but are not limited to the following:

- *Corporate Guideline No. 35: Listing and Recovery of Threatened Species and Ecological Communities* (Parks and Wildlife, 2015a)
- *Corporate Guideline No. 36: Recovery of Threatened Species Through Translocation and Captive Breeding or Propagation* (Parks and Wildlife, 2015b)
- *Corporate Policy Statement No. 35: Conserving Threatened Species and Ecological Communities* (Parks and Wildlife, 2015c)
- *A framework for fauna conservation* (Parks and Wildlife, 2016a)
- *Western Shield Plan 2017-2026* (Parks and Wildlife, 2017)
- *South Coast Regional Fire Management Plan 2009-2014* (DEC, 2009)
- *Natural Diversity Recovery Catchment Program 2010 Review* (Wallace *et al.*, 2011)
- *WA Wildlife Management Program No. 44: South Coast Threatened Birds Recovery Plan* (Parks and Wildlife, 2014b)
- *WA Wildlife Management Program No. 47: Western Trout Minnow (*Galaxias truttaceus hesperius*) Recovery Plan*. (DEC, 2008d)
- *Interim Recovery Plan No. 62: Dwellingup Synaphea (*Synaphea stenoloba*) Interim Recovery Plan 2000-2003* (CALM, 2000b)
- *Interim Recovery Plan No. 135: Remote Thorny Lignum (*Muehlenbeckia horrida* subsp. *abdita*) Interim Recovery Plan 2003-2008*. (CALM, 2003)
- *Interim Recovery Plan No. 236: Selena's Synaphea (*Synaphea* sp. Fairbridge Farm) Interim Recovery Plan 2007-2012* (DEC, 2007)
- *Interim Recovery Plan No. 256: Glossy-leafed Hammer Orchid (*Drakaea elastica*) Interim Recovery Plan 2008-2013* (DEC, 2008a)
- *Interim Recovery Plan No. 272: Grand Spider Orchid (*Caladenia huegelii*) Interim Recovery Plan 2008-2013* (DEC, 2008b)
- *Interim Recovery Plan No. 344: Prickly honeysuckle (*Lambertia echinata* subsp. *echinata*) Interim Recovery Plan 2014-2019* (Parks and Wildlife, 2014a)
- *Interim Recovery Plan No. 57: Shrubland and Woodlands on Muchea Limestone Interim Recovery Plan 2000-2003* (CALM, 2000a)
- *Interim Recovery Plan No. 92: Unwooded Fresh Water Lakes of the Southern Wheatbelt of Western Australia, dominated by *Muehlenbeckia horrida* subsp. *abdita* and *Tecticornia verrucosa* across the lake floor and, *Muehlenbeckia horrida* subsp. *abdita* Interim Recovery Plan 2001-2006* (CALM, 2001)
- *Interim Recovery Plan No. 339: Scott River Ironstone Association (update) Interim Recovery Plan 2015-2020* (Parks and Wildlife, 2015d)

- *Interim Recovery Plan No. 354: Clay pans of the Swan Coastal Plain 2015-2020* (Parks and Wildlife, 2015e)
- *Management Plan No. 90: Albany Coast Parks and Reserve* (DBCA, 2017)
- *Management Plan No. 85: Swan Coastal Plain South* (Parks and Wildlife, 2016c)
- *Management Plan No. 84: Esperance and Recherche parks and reserves* (Parks and Wildlife, 2016b)
- *Management Plan No. 60: Lake McLarty Nature Reserve* (DEC, 2008c)
- *Management Plan No. 54: Thomsons Lake Nature Reserve Management Plan* (CALM, 2005b)
- *Management Plan No. 53: Forrestdale Lake Nature Reserve Management Plan* (CALM, 2005a)
- *Management Plan No. 7: Benger Swamp Nature Reserve Management Plan* (CALM, 1987)
- *Two People's Bay Nature Reserve Management Plan 1995-2005*(CALM, 1995)
- *Star Swamp Bushland Reserve Environmental Management Plan* (Natural Area Consulting, 2012)
- *Approved Conservation Advice for Botaurus poiciloptilus (Australasian bittern)* (CTSSC, 2011a)
- *Ecological Character Description for the Forrestdale and Thomsons Lakes Ramsar Site (A report to the Department of Environment and Conservation)* (Murdoch University, 2009)
- *Ecological Character Description of the Muir-Byenup System Ramsar Site South-West Western Australia (Report prepared for Department of Environment and Conservation)* (CENRM, 2009)
- *Ecological Character Description for the Peel-Yalgorup Ramsar Site (A report to the Department of Environment and Conservation and Peel-Harvey Catchment Council)* (Hale and Butcher, 2007)
- *Ecological Character Description for the Vasse-Wonnerup Wetlands Ramsar Site South-west Western Australia (Report prepared on behalf of the Department of Environment and Conservation and GeoCatch)* (Creagh et al., 2007)

11 Guide for decision makers

Under the Commonwealth EPBC Act any person proposing to undertake actions that may have a significant impact on listed threatened species (including the Australasian bittern) should refer the action to the relevant Minister in accordance with the EPBC Act requirements. The Minister will determine whether the action requires EPBC Act assessment and approval. As these provisions relate to proposed future actions, they can include actions which may result in increased impact from existing threats or potential threats, and actions which may result in a new threat. Whether or not an action is likely to have a significant impact depends upon the sensitivity, value and quality of the component of the species' environment which is impacted, and upon the intensity, duration, magnitude and geographic extent of the impacts. The potential for an action to have a significant impact will therefore vary from case to case.

Possible future actions that may constitute a 'significant impact' on the Australasian bittern include any action that:

- leads to loss and/or degradation of water quality or change in water levels in suitable Australasian bittern habitat;
- results in a reduction in the suitability of habitat for the Australasian bittern; and
- increases the likelihood of predation of the Australasian bittern beyond natural levels.

Specific factors that may impact Australian bitterns include:

- increased numbers of foxes, feral cats, deer, horses or pigs in areas used by Australasian bitterns;
- increased fragmentation of habitat;
- inappropriate fire regimes which result in fragmentation or loss of suitable habitat;
- increased human activity that leads to degradation or disturbance of habitat;
- increased land clearing that leads to cumulative loss or degradation of available foraging, nesting, feeding, or migration habitat;
- actions that prevent natural regeneration of habitat;
- hydrological changes in wetlands that result in a modification or reduction in the area of existing habitat;
- reduction in environmental water availability that reduces the density and persistence of the vegetation comprising the habitat; and
- actions leading to chemical contamination of habitat associated with activation of acid sulphate soils, application of mosquito control and agricultural and other chemicals.

12 Recovery

12.1 Recovery goals and objectives

This recovery plan guides the recovery of the Australasian bittern in Western Australia for 10 years. The overarching objective is to abate known threats and identify emerging threats to the Australasian bittern in Western Australia and maintain and enhance wetlands currently or potentially supporting the species to ensure long-term conservation in the wild.

The species recovery objectives for the next 10 years, in a general order of priority, are:

1. Characterise and map habitat critical to the survival of the Australasian bittern.
2. Survey and monitor Australasian bittern populations and habitat.
3. Understand ecological requirements to improve conservation and management of the Australasian bittern and its habitat.
4. Protect habitat and manage threats for the long-term survival of the Australasian bittern.
5. Increase community awareness and participation in the conservation of the Australasian bittern.

Criteria for success

The recovery plan will be deemed successful if, within the 10 year life of this plan, the following are achieved:

- Australasian bitterns remain extant at viable important wetland suites⁴ in Western Australia; and
- The area and quality of habitat is maintained or increased in the important wetland suites monitored⁵.

Criteria for failure

This recovery plan will be deemed unsuccessful if, within the 10 year life of this plan, either of the following occur:

- Australasian bitterns do not persist in all viable important wetland suites in Western Australia; or
- There is a decline in habitat quality or area of important wetland suites monitored.

⁴ Important wetland suites are identified in Section 2. The viability of these wetlands is to be assessed (refer to Section 12.2, Recovery Action 1.4).

⁵ Monitoring undertaken at important wetland suites is listed in Section 9.

12.2 Recovery actions

Where recovery actions are needed or appropriate on lands other than those managed by DBCA, permission, coordination or collaboration, as appropriate, will be sought from appropriate owners/land managers prior to recovery actions being undertaken. The following recovery actions are generally in order of priority, influenced by their timing over the life of the plan. However, this should not constrain addressing any of the actions if funding is available and/or other opportunities arise.

Priorities are assigned to recovery actions. The three levels of priorities should be interpreted as follows:

- Priority 1: Taking prompt action is necessary in order to mitigate the threats and ensure the persistence of the species.
- Priority 2: Action is necessary to mitigate threats and work towards the long-term recovery of the species.
- Priority 3: Action is desirable, but not critical to recovery at this point in time but will provide for longer term maintenance of recovery.

Objective 1: Characterise and map habitat critical to the survival of the Australasian bittern

Habitat critical to the survival of the species is described, but research and monitoring data has not been fully collated or analysed in order to characterise or produce maps. Characterising, identifying and mapping habitat will allow recovery actions to be more targeted and prioritised to the most relevant sites. It is recognised that the wetland habitat is dynamic in nature and that existing data and monitoring programs are relevant and should be used to inform and support the development of habitat models.

Wetlands utilised by Australasian bitterns may provide different values in different parts of the wetland, or at different times of the year, or in different climatic conditions. For example, breeding habitat, feeding habitat, roosting areas, the impact of changes in hydrology in the habitat, or the effects of weed invasion or feral herbivores, may all vary between seasons and between wet and dry years. Documenting the characteristics of suitable Australasian bittern habitat, and establishing baseline data, are important to detect changes in the condition.

Action	Description	Priority	Performance Criteria
1.1	Characterise and map suitable and potential habitat, including habitat characteristics, habitat quality and Australasian bittern occurrence history.	1	<p>Current research, survey and monitoring data is captured and collated.</p> <p>Characteristics of habitat known to support, or potentially support Australasian bittern are defined.</p> <p>Maps of suitable and potentially suitable habitat are produced, based on habitat suitability models, and including habitat quality and viability.</p> <p>Maps and other derived information are used to guide monitoring and management actions.</p>
1.2	Provide spatial mapping products to relevant stakeholders and land managers, including DBCA, Department of Fire and Emergency Services (DFES), relevant private landholders, planners, and NRM and community groups.	2	<p>Habitat maps and models are made available to relevant stakeholders and land managers.</p> <p>Relevant stakeholders and land managers are aware of and utilise spatial mapping products.</p>

Objective 2: Survey and monitor Australasian bittern populations and habitat

Monitoring Australasian bitterns can be challenging and has historically relied on quantifying calls. Future monitoring needs to consider the range and efficacy of methods used historically and consider new technologies such as audio recording units (ARU). Further research is needed to test and validate novel methods (refer to objective 3) and incorporate these into monitoring as appropriate. In addition, survey units need to be defined and variation in relation to stochastic changes in wetlands, and drivers of calling understood.

While it may be unlikely that significant occurrences of Australian bitterns have not been discovered to date, additional surveys should be undertaken to determine any new occurrences so that management priorities can be updated, and management implemented to protect those locations as required.

Action	Description	Priority	Performance Criteria
2.1	Develop and implement an Australasian bittern population monitoring program.	1	<p>Population monitoring program is designed, implemented and analysed, and includes:</p> <ul style="list-style-type: none"> • an index to track overall trends, • regular detailed monitoring at 10-15 key sites (derived from objective 1), and <p>Results of research into methodology is incorporated (derived from objective 3).</p>
2.2	Establish a monitoring program for Australian bittern habitat to detect changes in habitat area and quality.	1	<p>Habitat monitoring program is designed and implemented, and includes monitoring of:</p> <ul style="list-style-type: none"> • vegetation condition, • weed invasion, • water levels, • water chemistry • hydrology, • sedimentation, and • predator densities.

Action	Description	Priority	Performance Criteria
2.3	Periodically undertake additional surveys in potential habitat (derived from Objective 1) to detect new occurrence.	2	Surveys of potential habitat are undertaken.
2.4	Undertake analysis and interpretation of both population and habitat monitoring data and communicate findings to stakeholders.		Monitoring findings are analysed, interpreted and communicated to stakeholders to inform management.
2.5	Develop a shared system to collate population and habitat monitoring results and improve data management and sharing.	3	All monitoring data (including both population and habitat data) is input into a single, shared system (database). Presence data is also available via NatureMap.
2.6	Calculate the extent of occurrence and area of occupancy of Australasian bitterns based on consolidated survey results.	3	Extent of Occurrence (EOO) and Area of Occupancy (AOO) is calculated using all available data.

Objective 3: Understand ecological requirements to improve conservation and management of the Australasian bittern and its habitat

Effective conservation of the Australasian bittern is dependent on having a good understanding of its ecological requirements including life history characteristics and ecological processes that are associated with food chains, breeding and habitat requirements, and the interaction of these characteristics and processes with the conservation and management of the species. Once this information is available, critical thresholds can be determined and targeted recovery strategies developed.

Action	Description	Priority	Performance Criteria
3.1	<p>Identify and prioritise knowledge gaps and engage with researchers to facilitate research to fill the identified gaps.</p> <p>Current knowledge gaps or opportunities include:</p> <ul style="list-style-type: none"> • population viability assessment (PVA) to understand the importance of different life stages for the population and identify additional knowledge gaps; • identification of critical threshold limits affecting habitat suitability for breeding success; • identification of wetland characteristics required to support Australasian bitterns in terms of food resources; • understanding of the relationship of hydrological processes on Australasian bittern use of habitat; • understanding of bird movements (i.e. tracking studies) and how and why bitterns use certain wetland suites; • food availability and seasonal changes in prey abundance; • impacts of frequent fire and fire in different seasons; • effect of introduced predators on Australasian bitterns; • genetic analysis to understand local population dynamics (including protocols for feather collection); • test novel monitoring techniques. 	1	<p>Knowledge gaps are identified.</p> <p>Research topics are prioritised and communicated to relevant research institutions.</p> <p>Knowledge gaps are filled and used to inform management.</p>
3.2	Facilitate science communication and the interpretation of research findings to inform management.		Research findings are communicated to stakeholders and used to inform management.

Objective 4: Protect habitat and manage threats for the long-term survival of the Australasian bittern

In consultation with land managers, seek to protect lands and wetlands that contain resident populations, or potential populations, of Australasian bitterns, through mechanisms that will protect the lands in perpetuity. Options may include Crown reserves, conservation covenant in consultation with land managers, declared environmentally sensitive areas (ESAs) under *Environmental Protection Act 1986* and/or as critical habitat under the *Biodiversity Conservation Act 2016*.

Once important and potential habitat is defined and characterised (see objective 1), and if possible protected, it is important to manage or mitigate threats. The main identified threats to Australasian bitterns all relate to management of habitat, and have been identified as altered hydrology, climate change, inappropriate fire regimes, habitat damage and predation. The ability to effectively manage or mitigate some of these threats needs to be underpinned and informed by research (refer to objective 3).

Fire management in the vicinity of existing or potential habitat for Australasian bitterns will be appropriate to protect feeding and breeding habitat in both the wetland and fringing wetland vegetation. The introduction of fire into Australasian bittern habitat needs to be carefully considered. Fire should not be deliberately introduced to bittern wetlands except where research indicates that fire is desirable.

It is important to monitor the condition of Australasian bittern habitat (objective 2), to identify changes that may require management intervention, and to evaluate current management practices.

Action	Description	Priority	Performance Criteria
4.1	Identify areas of the highest priority habitat for protection and investigate mechanisms for improved long-term protection.	1	<p>High priority habitat is identified (derived from objective 1) and prioritised.</p> <p>Purchasing land to include additional Australasian bittern sites in department-managed land has been considered.</p> <p>Other effective strategies to protect habitat implemented on both public and private lands.</p>

4.2	Encourage land managers with resident populations, or potential populations of Australian bittern to manage and protect habitat.	1	Land managers contacted to discuss the opportunities for conserving Australasian bittern habitat on their lands. Effective strategies to encourage land managers to protect habitat are implemented.
4.2	Manage habitat known to be critical to the survival of Australasian bitterns by conducting on-ground works. Some examples of possible short-term actions include: <ul style="list-style-type: none"> • work with water management agencies to ensure adequate environmental water flows to important wetlands; • divert water in or out of wetlands; • re-establish water retention (drain closure); • buffer wetlands through revegetation; • eradicate or control weeds; • fence to exclude stock and/or predators; • control feral predators; and • ecological fire management. 	1	Effective strategies to manage various habitat aspects are implemented at sites with habitat critical to the survival of the Australasian bittern.
4.4	Develop and implement a fire management strategy for key Australasian bittern sites with key stakeholders.	1	Fire Management Strategy produced for key Australasian bittern sites which includes up to date and accessible information to minimise the impact of fire suppression activities on Australasian bitterns and recommendations for post-fire monitoring to understand impacts on habitat characteristics and population dynamics. Relevant and up to date Australasian bittern information regularly provided to fire managers.
4.5	Identify critical levels of predation affecting breeding success and design and implement introduced predator control programs where necessary.	1	Predator control program designed and implemented where necessary on both public and private lands.

Objective 5: Increase community awareness and participation in the conservation of the Australasian bittern

Collaboration between organisations, the community and land managers are the key to implementing this recovery plan. There are already excellent examples of existing collaborations and these need to be supported and fostered (i.e. DBCA and BirdLife WA, NRM groups, research institutions). However, there are opportunities to improve and seek new collaborations, particularly to better engage Aboriginal groups and other landholders/managers in the conservation of Australasian bitterns.

Action	Description	Priority	Performance Criteria
5.1	Promote awareness of Australian bitterns and wetland conservation values.	3	Information campaign developed and implemented. Profile of the Australasian bittern increased. Increase recognition of the importance of freshwater vegetated wetlands.
5.2	Involve Aboriginal groups and volunteers from the local community and other local organisations and interested individuals in surveys.	3	Volunteers engaged in surveys.
5.3	Engage volunteers in citizen science opportunities (e.g. Feathermap)	3	Citizen science projects implemented.
5.4	Ensure that landowners, catchment groups and other stakeholders are aware of the financial assistance available for nature conservation work through existing and new funding programs.	2	Existing and new funding programs identified. Land managers informed of funding programs.
5.5	Educate and encourage land managers to manage habitat critical for the long-term survival of known Australasian bittern wetlands. This may include communicating information related to the impact of adverse water levels, weed control, grazing control, buffering of wetlands against nutrient flows, and re-establishment of hydrological processes.	1	Land managers provided with information on managing habitat and opportunities for conserving Australasian bittern habitat on their lands. Effective strategies for communicating relevant knowledge implemented, such as developing an information package.

13 Implementation and evaluation

The coordination and implementation of this recovery plan will be overseen by the Western Australian Department of Biodiversity, Conservation and Attractions. This may involve an Australasian bittern recovery team or working group/s consisting of representatives directly involved in addressing recovery actions and management of Australasian bittern populations, habitats and threats. DBCA recognises that partnerships will need to be developed for effective coordination and delivery of the recovery actions.

This recovery plan is for a minimum of 10 years from the date of its adoption, or until replaced. DBCA, in consultation with the recovery team, will review and evaluate the performance of this recovery plan, and in particular the performance against the success criteria. The recovery plan must be reviewed at intervals of no longer than five years, or sooner if necessary. All Australasian bittern recovery initiatives will be documented and made available for the periodic reviews. The recovery plan may be revised in light of such a review, and as other information or research findings become available.

The estimated cost of implementing this recovery plan is \$2,065,000 over the first five years (Table 2). However, the estimated figures do not include costs associated with the ongoing management of habitat by DBCA, other government agencies and private land owners, including the baiting of department land currently associated with the Western Shield Program and fire management. Nor does it include costs associated with mitigating loss of habitat due to development that may be approved and undertaken over the next 10 years. These estimates do not account for inflation over time.

1. Characterise and map habitat critical to the survival of the Australasian bittern.
2. Survey and monitor Australasian bittern populations and habitat.
3. Understand ecological requirements to improve conservation and management of the Australasian bittern and its habitat.
4. Protect habitat and manage threats for the long-term survival of the Australasian bittern.
5. Increase community awareness and participation in the conservation of the Australasian bittern.

Table 2: Summary of indicative costs (\$) associated with recovery actions over the first five years of this Recovery Plan.

Recovery Objective	Year 1	Year 2	Year 3	Year 4	Year 5	Total
Characterise and map habitat critical to the survival of the Australasian bittern.	100,000	50,000	50,000	20,000	20,000	340,000
Survey and monitor Australasian bittern populations and habitat.	100,000	75,000	75,000	50,000	50,000	250,000
Understand ecological requirements to improve conservation and management of the Australasian bittern and its habitat.	100,000	100,000	100,000	50,000	50,000	400,000
Protect and manage threats for the long-term survival of the Australasian bittern.	200,000	200,000	200,000	200,000	200,000	1,000,000
Increase community awareness and participation in the conservation of the Australasian bittern.	20,000	20,000	15,000	10,000	10,000	75,000
Annual Cost	520,000	445,000	440,000	330,000	330,000	2,065,000

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14.1 Personal communication

- Alan Clarke (DBCA), 2012 and 2017
- Andrew Silcocks (BirdLife Australia), 2009.
- Ian Wilson (DBCA), 2017
- Robyn Pickering (BirdLife Australia), 2012 and 2017.
- Roger Hearn (previously Parks and Wildlife), 2012.
- Sarah Comer (DBCA), 2012

Appendix I

Maps depicting wetlands and locations mentioned in the recovery plan.



Figure 3: Map of wetlands and locations on the Swan Coastal Plain mentioned in the Recovery Plan.

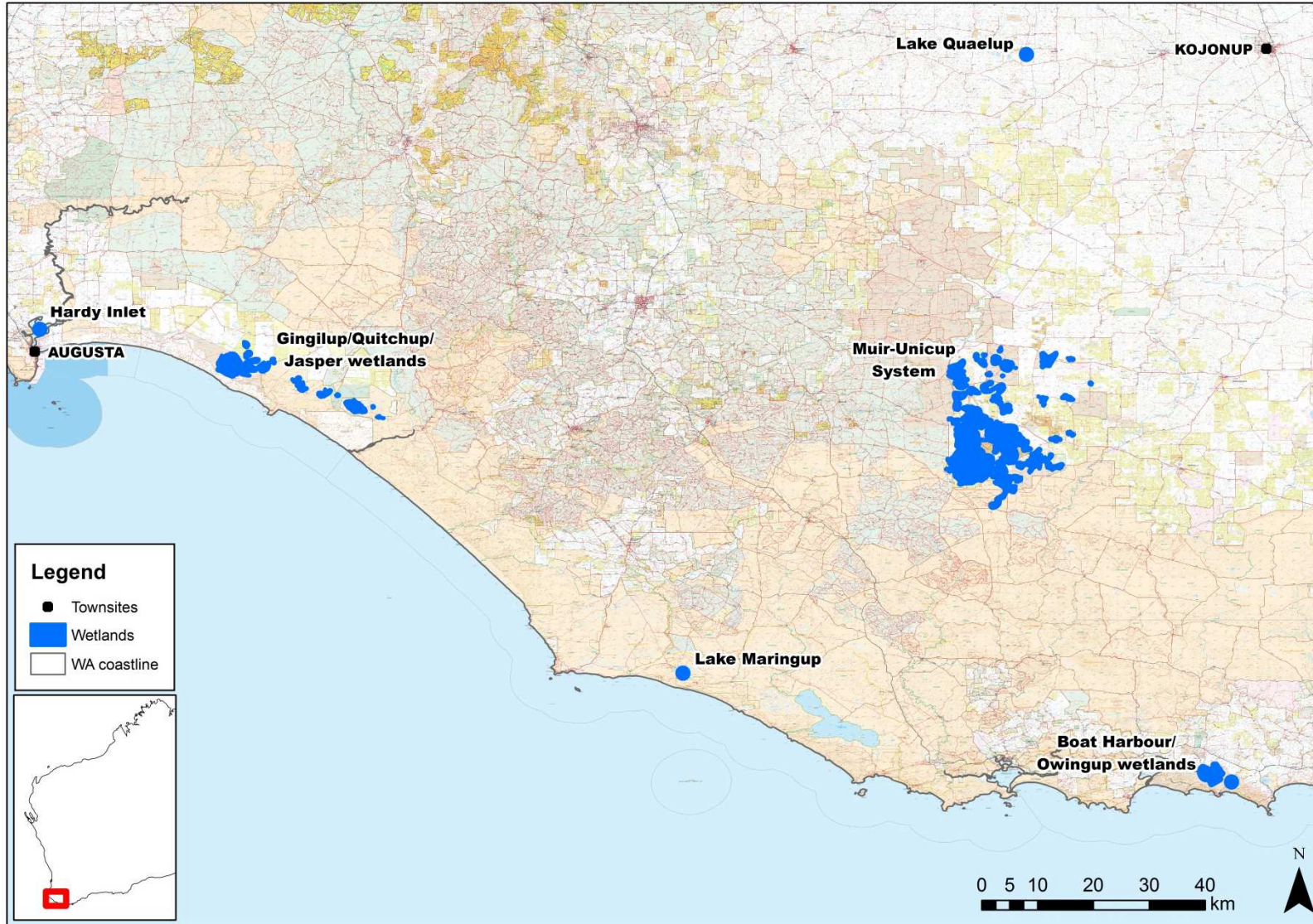


Figure 4: Map of wetlands and locations in the South West and Warren Regions mentioned in the Recovery Plan.

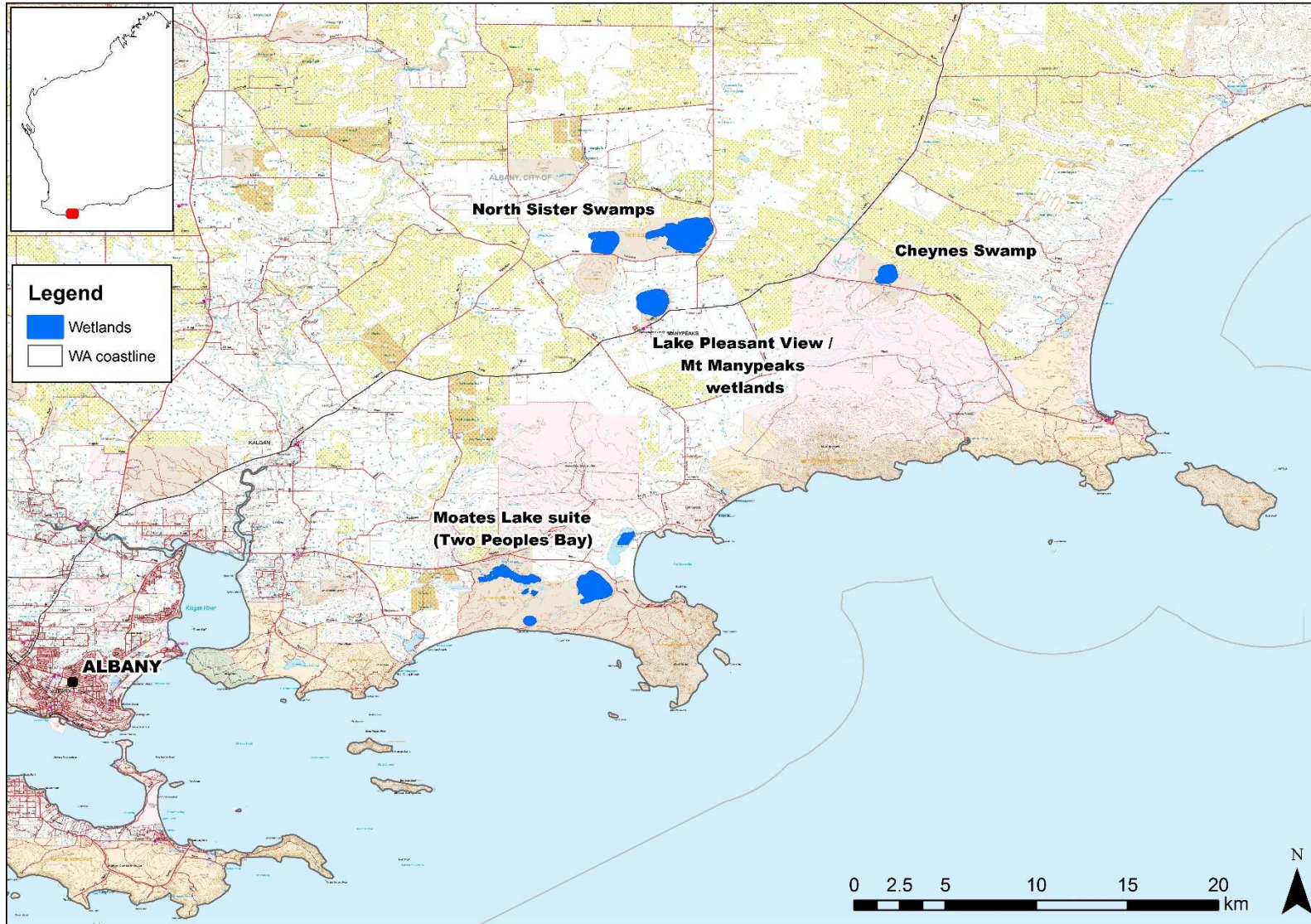


Figure 5: Map of wetlands and locations in the western section of the South Coast Region mentioned in the Recovery Plan.

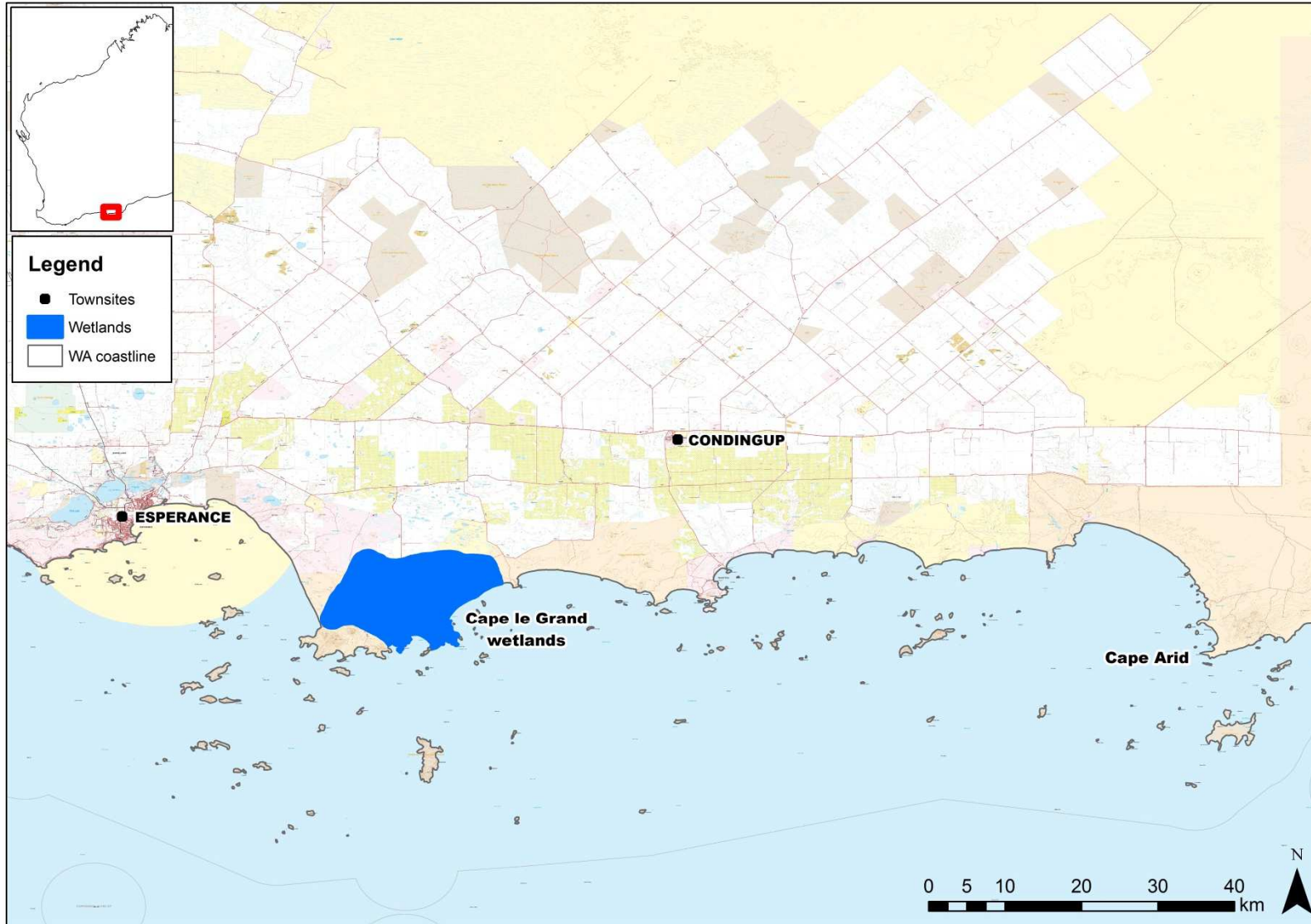


Figure 6: Map of wetlands and locations in the eastern section of the South Coast Region mentioned in the Recovery Plan.