Shorebird Population Monitoring and community engagement in Gulf St Vincent

2015-16 Annual Report to Adelaide and Mt Lofty Ranges Natural Resources Management Board

Chris Purnell , Robert Clemens and John Peter

January 2017

BirdLife Australia

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Cover photos:
BirdLife Australia staff conducting shorebird training, Thompsons Beach – Chris Purnell
Red-necked Stint arrive at a roost on Pt Prime shoreline– Chris Purnell

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We also acknowledge the cooperation of Ridley Corporation, Cheetham Salt and contractors EBS Ecology, eco Aerial and Brett Lane and Associates for allowing access to the Dry Creek and Price Saltfields, sharing their valuable knowledge on the sites' operation and salinity and ecology data.

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A Red Knot leads a flock of Banded Stilt to a Pt Prime roost site: Chris Purnell

EXECUTIVE SUMMARY

Populations of shorebirds (also known as 'waders') are declining throughout the world. Their long-term survival will require managers and planners to identify and protect their habitats, identify and reduce the impacts of threats to their fitness, and identify population declines sufficiently early to limit their severity through sympathetic management. The importance of the conservation of migratory shorebirds has been confirmed, as they have been recognised as species of national significance in Australia's *Environment Protection and Biodiversity Conservation Act* (1999), and also in several international conservation agreements to which Australia is a signatory.

Gulf St Vincent has long been recognised as an internationally and nationally significant area for shorebirds. With the cumulative effects of threats throughout the East Asian—Australian Flyway and the decline in the habitat quality of the Coorong driving regional population declines, the conservation of key terminal migration habitats in Gulf St Vincent will be crucial to the national conservation effort. The South Australian Government, Department of Environment, Water and Natural Resources and Adelaide and Mt Lofty Ranges Natural Resources Management Board in conjunction with local councils should be commended in their efforts to secure shorebird habitat values through a large portfolio of works culminating in the declaration of the formulation of the *Adelaide International Bird Sanctuary an the successful* listing of the site as an *East Asian Australasian Flyway Network Site of significance*.

As a result of further fieldwork, literature reviews, a review of development proposals, and managers' and stakeholders' workshops, it seems clear to BirdLife Australia that:

a) Disturbance and habitat loss/degradation are the two greatest threats to shorebirds in the region;
b) Intensifying anthropogenic disturbance on the intertidal zone of Samphire Coast's northern Beaches (Pt Prime- Parham) is having a deleterious effect on important shorebird habitat of international significance. Immediate intervention is necessary.
c) The increased severity and regularity of climate change induced storm events has highlighted the necessity for conservation of key intertidal retreat zones throughout the samphire coast.
d) The artificial wetlands of the Dry Creek Saltfields support the greatest abundance of shorebirds in the region (15,000 on average) and add resilience to the regional population that is irreplaceable. Informed adaptive management of these habitats will be required to maintain shorebird populations now that salt production has ceased;
e) The Dry Creek Saltfields site provides unparalleled ecological community and tourism opportunities.
f) As an active operation Dry Creek Saltfields contained regionally unique habitat values and only a site management plan that ensures no net loss of shorebird habitat values (site scale and gulf scale) should be accepted.
g) Transitioning of ponds from wet to dry as part of Ridley Corporation's holding pattern are providing temporary, substitute habitat after the disruption of the operational salinity gradient.
h) Significant refuge habitat on Section Bank/Bird Island should be secured and optimised by increasing pest control and reducing recreational visitation;
i) The Northern Connector Project is a major project that may directly impact on shorebird habitat, through impacts to existing built stormwater wetlands. Opportunities exist to provide freshwater (and potentially tidal) offsets in areas west of Barker Inlet wetlands and the Section 2 ponds of Dry Creek;
j) Working groups administering the Adelaide International Bird Sanctuary and the rehabilitation plan for the Dry Creek Saltfields should continue to consult the abundance of literature and expertise made available by experts in the development of future strategic planning for shorebird conservation.

This report: (a) repeats an overview of shorebirds, habitats and threats; (b) provides details of the 2015–16 counts (A total of 97 counts were submitted by 28 counters, equating to approximately 678 hours contributed by citizen scientists.); (c) reports on training and awareness events conducted in 2015–16 (d) provides information that is relevant to the management of shorebirds and the threats they face in Gulf St Vincent.

We look forward to another year in which we can further inform on how to optimise shorebird monitoring and conservation effort in Gulf St Vincent.

1. INTRODUCTION

Gulf St Vincent has long been recognised as an internationally significant area for shorebirds (Close 1983, Lane 1987, Wilson 2000, Close 2008, Bamford *et al.* 2008) and over the last 25 years, counts of migratory shorebirds throughout wetlands of the region have been conducted by volunteer counters from organisations including the Australasian Wader Studies Group and Birds South Australia.

The importance of migratory shorebird conservation is widely documented, and as indicators of wetland health, shorebirds are considered to be good flagship species for wetland habitats, both nationally and internationally. There has been an increased need for shorebird conservation in recent years, with evidence that migratory shorebird populations are declining throughout the world (Morrison *et al*. 2001; IWSG 2003; Olsen *et al*. 2003; CHSM 2004; van de Kam *et al*. 2004), including a growing body of evidence that suggests populations are declining in Australia (Gosbell & Clemens 2006; Nebel *et al*. 2008; BirdLife Australia unpublished data). With this in mind, the Adelaide and Mount Lofty Ranges Natural Resources Management Board (NRM) provided funding to BirdLife Australia to coordinate a complete count of the shorebirds within Gulf St Vincent, including supplementary surveys of poorly known shorebird habitat. Commencing in 2009, the project aimed to reinvigorate shorebird population monitoring and identify important shorebird habitats in the region. The resulting reports and associated GIS layers provide an inventory of shorebird habitats and highlight the distribution and abundance of shorebirds in Gulf St Vincent, as well as identifying current and potential threats to shorebirds in the region. Work also included conducting shorebird training workshops to recruit, train and inform counters. Additional funding from the Adelaide and Mount Lofty Ranges NRM Board will allow this work to continue until 2018.

This report highlights the results to July 2016. Work between July 2009 and June 2016 has increased the number of active, trained volunteers required to carry out shorebird surveys in Gulf St Vincent, increased the spatial resolution of mapping and identified priority shorebird habitats and the threats affecting them in Gulf St Vincent. Associated work in 2015–16 also included the coordination of four simultaneous counts of shorebirds in Gulf St Vincent, workshops to recruit and train counters, further banding expeditions, by Friends of Shrebirds SE and Victorian Wader Study Group, to increase our knowledge of bird movements. We have also increased our understanding of the threats to shorebirds in Gulf St Vincent as well as the types of management required to ensure long-term shorebird conservation. Data was also incorporated into a flyway wide review of shorebird population estimates. The project also contributed data to assist with the South Australian governments proclamation of the Adelaide International Bird Sanctuary as well as the successful East Asian Australasian Flyway Site nomination of Gulf St Vincent.

The reinvigoration of shorebird monitoring in Gulf St Vincent has provided valuable information to BirdLife Australia's Shorebirds 2020 program, which coordinates national shorebird population monitoring. Shorebirds 2020 was initiated in 2007 in response to growing concern over declining shorebird populations in Australia and the need to reliably determine population trends for the various species of shorebirds. The aim of Shorebirds 2020 is to collect data on the populations of shorebirds, and this can be used to aid their conservation and management. Specifically, the aim is to understand national (and, where possible, site-based) population trends, and explore the potential causes of change through increasing our understanding of the relationship between habitat, habitat quality and threats, and how they interact to affect the distribution and abundance of shorebirds in Australia.

Recent work has identified a need to conduct annual surveys at over 150 sites throughout Australia to detect the national population trends of migratory and resident species of shorebirds. Gulf St Vincent is considered the second-most important shorebird area in South Australia due to its abundance and diversity of species of shorebirds, and it is crucial in terms of areas that must be surveyed to determine national population trends.

With projected growth estimates predicting that Adelaide's population will increase to 560,000 people (including 160,000 in the northern Adelaide region) in the next 30 years, it is vital to inform managers and planners about how to ensure the long-term conservation of shorebirds in Gulf St Vincent. This project has delivered some of the first steps required to achieve that long-term aim. Gulf St Vincent's shorebird habitats have been identified, mapped at fine scale and described with regard to the relative importance for shorebirds in each area. This should allow improved planning and threat minimisation. Awareness of the need for shorebird conservation has been raised within the birdwatching community and stakeholders involved in the management of shorebird habitat through workshops. These workshops, together with work by Birds South Australia, have also increased the number of skilled shorebird counters.

Shorebird monitoring has been reinvigorated within Gulf St Vincent and steps are being taken to optimise that monitoring to inform on adaptive management of shorebird habitats. Results from recent analyses suggest current monitoring is sufficient to detect national shorebird trends, but significantly more counts would be required to identify anything other than a catastrophic (>70%) decline of shorebirds within Gulf St Vincent over 20 years. Fieldwork, literature reviews and stakeholder discussions have increased our understanding of the specific threats to shorebirds in Gulf St Vincent, and highlighted some of the management and conservation measures required to limit the impact of those threats. These threats are growing and it is clear that some pristine areas, such as the northern beaches, will need to be protected, while other areas will require active management to maintain shorebird populations. This report highlights the progress towards these required steps for long-term shorebird conservation in Gulf St Vincent, but ultimately shorebird conservation in the region will depend on the role that local planners and managers adopt.

Whilst previous work has focused on coastal areas north of Adelaide, natural resource managers are also aware of the need to conserve and manage other shorebird habitats in the region. Recent work and survey count effort has also focussed on shorebird habitats in the Willunga Basin, such as the Onkaparinga Estuary and Washpool Lagoon.

Section 1.01 Background Information on Shorebirds, Habitats and Threats

a) What are shorebirds?

Shorebirds (also known as 'waders') in Gulf St Vincent include sandpipers, plovers, stints, oystercatchers, godwits, curlews, knots and greenshanks. Shorebirds of the region are characterised by their general association with wetlands. There is no agreed taxonomic or morphological definition of a shorebird; they are a somewhat arbitrary group within the Order Charadriiformes. This order also includes non-shorebirds such as gulls, terns, auks and button-quail. In Australia, shorebirds are categorised as either migratory or resident: 36 species of migratory shorebirds regularly spend their non-breeding season in Australia, having flown up to 13,000 kilometres from their breeding grounds; and 18 species of resident shorebirds breed in Australia, remaining here throughout the year (Geering *et al*. 2007).

The two million migratory shorebirds that visit Australia each year hatch in the arctic tundra of Russia and Alaska, in meadows within the belt of boreal forests in the Northern Hemisphere, or in the rugged deserts and steppes of the middle-northern latitudes, in places such as Mongolia and northern China. Many shorebirds hatch into the care of a male and female which travel to breed in the same place, year after year. Others hatch in areas where food was plentiful at that time, where either the male or the female may mate with many partners, leaving the parental care to their many mates. A few hatch into families where the male takes care of one clutch of eggs while the female cares for a second. No matter where they were born, or the type of family they come from, all grow quickly before they embark on a remarkable journey (Figure 1).

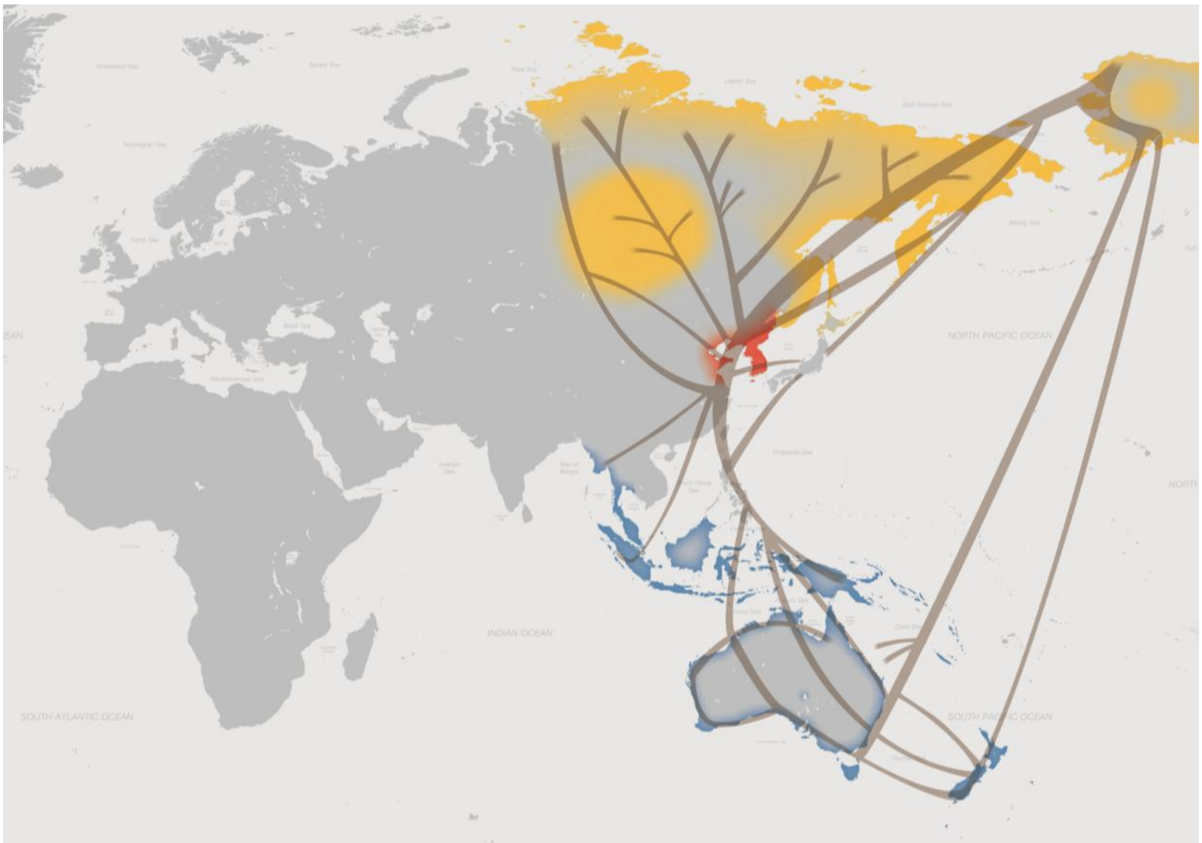


Figure 1. Every year more than 2 million shorebirds travel back and forth between their Arctic breeding grounds (yellow) and their Australasian non-breeding areas (blue), travelling along migration routes (dark grey). These routes are complex and numerous and are stylised in this representation (Image BirdLife Australia).

Almost as soon as a shorebird hatches it is able to walk and forage on its own. Parental care consists mostly of distracting predators, such as Arctic Foxes or Snowy Owls, and leading young to patches of food. When the chicks are only six weeks old, the mother often leaves on her migration to the Southern Hemisphere, and the father often follows about a week later. The chicks are fully grown just eight weeks after hatching, and they must fly south without their parents or else they risk freezing in the coming snows. In a physiological frenzy, the young birds may increase their mass by up to 80 per cent until their body mass comprises 55 per cent fat, their weight increasing by 2–5 per cent each day. Just before they leave on migration, the young birds' feeding organs shrink, their heart expands and their blood thickens. Then they set off south, burning their accumulated fat at a rate of up to 1 gram each hour, flapping constantly as their body, heart and muscles atrophy. Avoiding aerial predators and poor weather along the way, the most difficult aspect of the journey is navigating distances of up to 13,000 kilometres by instinct, as there are no older birds to guide them. They fly non-stop for days at time, and most are only able to last about half the journey before they need to stop to feed so that they can again increase their body mass to provide sufficient energy to complete the journey. The areas they stop at must be rich intertidal ecosystems with abundant food sources.

A few shorebirds have been shown to complete their flight in one hop. Some Bar-tailed Godwits were tracked flying directly from Alaska to New Zealand over nine days, comprising a non-stop 11,000-kilometre trip across the Pacific Ocean. On such long flights, there is evidence which suggests that: these birds can rest different parts of their brains independently; they can see lines of polarity in the sky (like seeing a compass); they can sense low-frequency, long-distance travelling sounds called infrasound (a sound made by crashing waves, among other things); and they can navigate by the position of the sun and moon and the movement of the stars. The Samphire Coast Icon Project has supported recent satellite tracking of Grey Plovers migrating from Thompson Beach to the arctic. These birds undertake a non-stop flight of over 7,000 kilometres over some 6 days to mainland China and Taiwan, before making their way to the Siberian coast and islands.

After completing their first migration by the time they are 3–4 months old, juvenile birds inhabit the tidal flats and wetlands of Australia, where they may remain for up to five years before migrating north again to breed. Meanwhile, adults migrate back and forth each year, building up their weight before each migration, and most appear to stop over to feed along the way. An extra refuelling stop on the northward migration may be necessary because their destinations in the high latitudes of the Northern Hemisphere are still cold when the birds arrive, and they need to have sufficient energy to breed successfully.

Unfortunately, these critical stop-over sites are being destroyed at an alarming rate, and this appears to be driving both long and short-term population declines in migratory shorebirds. In the past 25 years, some of these species have declined by 50 to 80 per cent, and at least one species, the Great Knot, has experienced declines of 20 per cent in just five years (BirdLife Australia unpublished data). Up to 150,000 shorebirds of various species went missing in a single year after the destruction of just one vital tidal ecosystem in the Yellow Sea (shown in red in Figure 1) (Rogers *et al*. 2009). The Eastern Curlew and Great Knot were both listed as Vulnerable on the IUCN Red List recently after major population declines were detected, but more work is needed to monitor further changes and explore how widespread these declines are.

Given the size of the area that migratory shorebirds rely on to survive each year, their conservation is not simple. It requires a level of international cooperation to maintain the vital habitats that occur from Siberia to Australia on which shorebirds rely to survive. However, Australia is uniquely placed to use good science to understand how shorebird populations may be changing. Without such knowledge it is difficult to make the case for the protection of shorebird habitats, to discover what is driving some of these declines, and what can be done to ensure shorebird populations can persist into the future.

b) Global shorebird population trends

Throughout the world, many populations of shorebirds appear to be declining (Wilson 2000; Morrison *et al*. 2001; IWSG 2003; Olsen *et al*. 2003; CHSM 2004; van de Kam *et al*. 2004; Murray *et al*. 2013). In 2003, trend estimates were available for 41 per cent of the 499 populations of shorebirds around the world. Of these, 44 per cent appeared to be declining, 13 per cent were increasing, 39 per cent were stable and 4 per cent had become extinct (Delaney 2003; IWSG 2003).

The population declines that were detected coincide with accelerating loss and degradation of shorebird habitat (UNEP 2006; Rogers *et al*. 2009; Murray *et al*. 2013). In the East Asian–Australasian Flyway, a disproportionately high number of shorebird species have been classified as threatened, and many are under increasing threat from habitat destruction (IWSG 2003; Murray *et al*. 2013). The Red List Index (RLI), which uses information from the IUCN Red List to track trends in the projected overall extinction risk of sets of species, is among the indicators adopted by the world's governments to assess performance under the Convention on Biological Diversity and the United Nations

Millennium Development Goals. Of the 49 Australian species which had deteriorated in status in the last 20 years, over half were migratory shorebirds or seabirds (Szabo *et al*. 2012). Population-trend analysis of the BirdLife Australia Shorebird 2020 database shows strong evidence of declines in the Australian populations of 12 species of migratory shorebirds, and evidence of declines evident in another eight species of shorebirds (BirdLife Australia unpublished data).

Recent analysis undertaken by the University of Queensland utilising BirdLife Australia Shorebird 2020 data (11,000 of the 93,000 counts from 153 shorebird areas across Australia, spanning the years from 1973 to 2014), revealed decreases in abundance in 12 of 19 migratory shorebirds (Clemens, unpublished data). Six of these species regularly occur in Gulf St Vincent and five have been observed in internationally significant numbers (>1% EAA flyway population) (Section 1.03a), however with rates of decline as high as 8 per cent per annum (Figure 2) numbers in the region have declined proportionately.

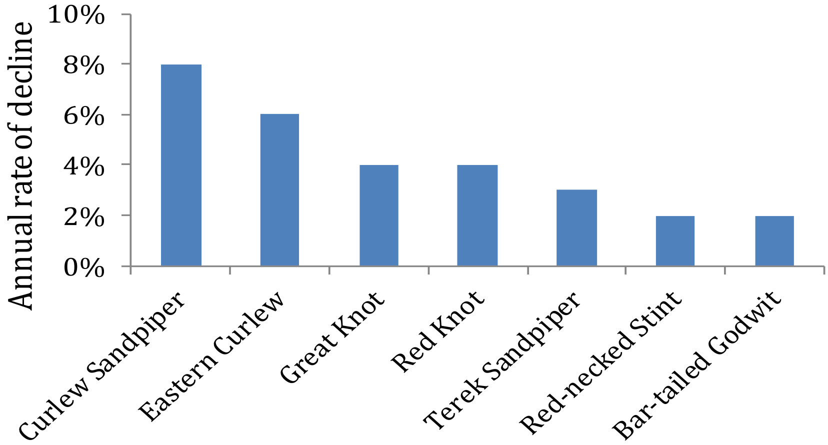


Figure 2. Rates of population decline of seven species of shorebirds in the East Asian–Australian Flyway (R. Fuller, unpublished data).

In alignment with these identified trends of decline, the following migratory shorebird species were listed as threatened under the Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act)

Critically endangered

- *Limosa lapponica menzbieri* (Bar-tailed Godwit (spp *menzbieri*)
- *Calidris tenuirostris* (Great Knot)

Endangered

- *Calidris canutus* (Red Knot)
- *Charadrius mongolus* (Lesser Sand Plover)

Vulnerable

- *Limosa lapponica baueri* (Bar-tailed Godwit (spp *baueri*)
- *Charadrius leschenaultii* (Greater sand Plover)

These species remain listed 'migratory' and 'marine' under the EPBC Act.

Of the species that are resident in Australia, the species of most concern is the Hooded Plover (Vulnerable EPBC), populations of which appear to be declining, due mainly to human disturbance during their nesting period, as well as degradation of their habitats (Weston 2003). In the Adelaide and Mt Lofty Ranges region, this species is found along the southern Adelaide and Fleurieu Coast. Conservation monitoring and management for this species on the Fleurieu has been underway since 2008 in collaboration with BirdLife Australia, Adelaide and Mt Lofty Ranges NRM Board, local councils and volunteers. Some decline is evident nationally for a further four resident species which occur in Gulf St Vincent.

Table 1. . List of East Asian-Australasian Flyway migratory shorebird species that visit Gulf St Vincent. WPE5 estimate is the current global population estimates summed across relevant subspecies for the EAAF (Wetlands International 2016).

Conservation status refers to IUCN status listed in Garnett et al. (2010), except for bolded species which are listed in the Environment Protection and Biodiversity Conservation Act 1999 (*EPBC* Act) (Department of the Environment 2016).

† these species have two or more subspecies which are recognised in the EAAF. Population estimates and thus, 1% population criterion, differ between subspecies and hence, the 1% criterion for each species is not presented here. See Waterbird Population Estimates (2016) for the most recent values.
* Bar-tailed Godwit subspecies menzbieri listed as Critically Endangered and subspecies baueri listed as Vulnerable under recent (5 May 2016) EPBC Act changes.

Scientific Name	Common Name	WPE5 estimate	1% EAAFP	Conservation status
Pluvialis fulva †	Pacific Golden Plover	135,000-150,000	1,350	
Pluvialis squatarola	Grey Plover	104,000	1,040	NT
Charadrius bicinctus	Double-banded Plover	50,000	500	
Charadrius mongolus †	Lesser Sand Plover	188,500-218,500	1,885	E
Charadrius leschenaultia	Greater Sand Plover	79,000	790	V
Gallinago hardwickii	Latham’s Snipe	25,000-1,000,000	250	
Limosa limosa	Black-tailed Godwit	139,000	1,390	V
***Limosa lapponica* †**	**Bar-tailed Godwit**	**279,000**	**2,790**	**CE * / V**
Numenius phaeopus	Whimbrel	55,000	550	NT
Numenius madagascariensis	**(Far) Eastern Curlew**	**32,000**	**320**	**CE**
Xenus cinereus	Terek Sandpiper	50,000-55,000	500	
Actitis hypoleucos	Common Sandpiper	50,000	500	
Tringa brevipes	Grey-tailed Tattler	44,000	440	NT
Tringa nebularia	Common Greenshank	100,000	1,000	
Tringa stagnatilis	Marsh Sandpiper	100,000-1,000,000	1,000	
Tringa glareola	Wood Sandpiper	100,000	1,000	
Arenaria interpres	Ruddy Turnstone	28,500	285	NT
Calidris tenuirostris	**Great Knot**	**290,000**	**2,900**	**CE**
***Calidris canutus* †**	**Red Knot**	**99,000-122,000**	**1,100**	**E**
Calidris ruficollis	Red-necked Stint	315,000	3,200	
Calidris subminuta	Long-toed Stint	25,000	250	
Calidris melanotos	Pectoral Sandpiper	1,220,000-1,930,000	12,200	
Calidris acuminate	Sharp-tailed Sandpiper	160,000	1,600	
Calidris ferruginea	**Curlew Sandpiper**	**135,000**	**1,350**	**CE**
Calidris pugnax	Ruff	25,000-100,000	250	

c) Shorebird trends in Gulf St Vincent

The number of counts available in the dataset for Gulf St Vincent differs strongly between sites. Therefore trend estimates for the entire population using data across all sites is coarse (as 2010 power analysis predicted). However when compared with the national network of shorebird sites with long term data Gulf St Vincent appears to be losing large numbers of multiple shorebird species most rapidly, along with Moolap Saltworks (VIC), the Hunter Estuary (NSW), the Coorong (SA), and Corner Inlet (VIC) (Clemens unpublished). All but one of these sites are highly modified systems where, along with additional threats mentioned in Section 1.02, habitat loss/alteration and disturbance are likely to be high.

Long term counts of Gulf St Vincent's Dry Creek Saltfields provide a larger dataset and smaller number of missing values than that of the greater region and can therefore be used to derive a reliable trend analysis, albeit on a smaller scale (Purnell 2012). Given the Dry Creek Saltfields dataset is not only more consistent than that of any other site but also includes an additional 11-year period of data (1979-1990), it was decided that this site alone would provide the best chance of identifying trends. Trend analysis using more sites in Gulf St Vincent will be attempted once consistent coverage is achieved.

Trend analysis completed by BirdLife Australia in 2012 revealed that six migratory species have undergone significant declines in the Dry Creek Saltfields since 1979. It is presumed that these declines reflect declines in the greater region, given simultaneous counts over the last six years have identified that an average of over 48 per cent of the shorebird population in Gulf St Vincent occurred in the Saltfields. The majority of the declines (between 55 to88 per cent) occurred between 1979 and 1990. It is probable that these declines are primarily connected to overall threats throughout the Flyway, but significant declines in two resident species (Red-capped Plover, 88 per cent, and Black-winged Stilt, 68 per cent) can only be attributed to local influences. These threats are discussed in more detail in Section 1.02 of this report.

d) Global and national recognition of the importance of shorebirds

Recognising that the long-term conservation of viable populations of the world's species requires the identification, protection and management of their habitats, many governments have initiated conservation measures and signed international conservation agreements. The international agreements pertaining to Australia's shorebirds include the Ramsar Convention, the World Heritage Convention, the Bonn Convention, the Convention of Biological Diversity, the Asia–Pacific Migratory Waterbird Conservation Strategy and the East Asian–Australasian Shorebird Reserve Network. There are also several bilateral agreements, including the China–Australia Migratory Birds Agreement (CAMBA), the Japan–Australia Migratory Birds Agreement (JAMBA) and, most recently, the Republic of Korea–Australia Migratory Bird Agreement (ROKAMBA). In addition, Australia's *Environment Protection and Biodiversity Conservation Act* (1999) recognises migratory shorebirds as species of National Environmental Significance (NES), further highlighting the importance of shorebird conservation. All of these agreements require the identification and protection of areas for conservation.

e) Shorebird requirements in Gulf St Vincent

Gulf St Vincent provides a diverse range of shorebird habitats that are vital for shorebirds to survive and reproduce. All shorebird habitats must provide a combination of feeding areas that are rich in available food and nearby roosting areas that allow shorebirds to rest without losing too much energy due to disturbance. Further, shorebird habitat must minimise the risk of predation by providing sufficiently open areas to allow shorebirds to detect and avoid predators. An ecosystem should provide a mosaic of suitable roosting and feeding habitats should one or more preferential sites become compromised. In a general sense shorebird feeding sites require:

- Readily accessible and abundant prey.
- Appropriate substrate resistance.
- Variety in prey type (between sp. & temporally).
- Large areas of shallow water (<20cm in depth).
- If tidal, low energy tidal influence (low gradient in tidal zone).
- If supratidal, maximum surface area of shoreline.
- Open uninterrupted views.
- Close proximity to appropriate roosting area.
- Close proximity to alternate feeding sites.

While roost sites require:

- Open uninterrupted views.
- Available throughout the tide cycle (including king tides).
- Sheltered from wind.
- Free of dense vegetation >10cm in height.
- Close proximity to appropriate feeding area.
- Close proximity to other roost sites.

Shorebird habitat types and preferences among species are further discussed in 0.

For resident shorebirds, the wetlands of Gulf St Vincent must also provide sufficient suitable habitat for successful breeding (0).

f) Conservation status of shorebird areas in Gulf St Vincent

Much of the identified shorebird habitat and adjacent areas in Gulf St Vincent are now legally protected within the reserve system that is administered by the Department of Environment, Water and Natural Resources, or occur within protected Australian Defence Force land or, until recently, commercial saltfields (Figure 3, Figure 4, Figure 5). The classified conservation areas include Clinton Conservation Park, Torrens Island Conservation Park, Port Gawler Conservation Park, Barker Inlet Aquatic Reserve, St Kilda–Chapman Creek Aquatic Reserve, Adelaide Dolphin Sanctuary, Upper Gulf St Vincent Marine Park, Lower Yorke Peninsula Marine Park and the newly gazetted Adelaide International Bird Sanctuary. Around 1,600[1] Hectares remains on freehold land. Much of this habitat occurs within the Dry Creek Saltfields. Future management of the saltfields are subject to an ongoing management planning process and are discussed further in Section 1.02. A literature study investigating potential options for future conservation management options for shorebirds is included in the 2014-15 report.

In March 2014, South Australian Premier Jay Wetherill announced a policy to create an Adelaide International Bird Sanctuary. The proposed Sanctuary's aim is to protect resident and migratory shorebirds along a contiguous 60-kilometre stretch of coastline from Dry Creek in the south to Port Parham in the north. The land, comprising a returned mining lease, existing Crown land and 2,300 hectares of recently State Government purchased freehold land, incorporates much of the significant terrestrial shorebird habitat along the Samphire Coast. It is proposed that land identified as suitable for inclusion in the sanctuary, which is likely to be the majority of Crown lands in the area, will be proclaimed as a conservation park under the National Parks and Wildlife Act 1972.

[1] This figure discounts significant shorebird habitat in the Price Saltfields which have not been mapped as part of this project.

Additional lands identified in 2014-15, totalling 1,955 hectares, increase connectivity and buffer areas within the proposed 9,461 hectare sanctuary. Much of the Sanctuary area lies adjacent to, or within, the Upper Gulf St Vincent Marine Park and Adelaide Dolphin Sanctuary, protecting connected habitats from the coast into the sea. These marine sanctuaries are particularly important in the conservation of extensive intertidal feeding areas for shorebirds (Figure 5). Various engineering, infrastructure and research projects will aim to optimise the conservation values of the region over the next three years.

Clinton Conservation Park is situated at the northern end of Gulf St Vincent and is recognised in the *Directory of Nationally Important Wetlands*. It covers over 18 km² and supports mangroves, tidal flats, and samphire and chenopod shrublands. It is the largest reserve in Gulf St Vincent, and one of the most significant sites in terms of shorebirds (Close & McCrie 1986; Watkins 1993).

Two large areas, including over 100,000 hectares of active salt ponds, were leased from the State Government for salt harvesting by Ridley Corporation, providing havens for shorebirds at the Dry Creek Saltfields on the east coast of Gulf St Vincent and the Price Saltfields on the west coast. In 2012, Ridley Corporation sold the Price Saltfields operation to Hong Kong-based CK Life Sciences, but retained the Dry Creek operation, which it later decommissioned in response to a lack of market demand for the brine it produced for soda ash production.

The coastline between Clinton Conservation Park and the Dry Creek Saltfields is known as the 'Samphire Coast', and it includes a variety of habitats that support many species of shorebirds. The area also has a number of small townships scattered along the coast as well as areas of agricultural land, small sand and shellgrit mines, and includes the target area for the Adelaide and Mount Lofty Ranges Natural Resources Management Board's federally funded *Samphire Coast Icon Project*. The developed areas are interrupted by a stretch of undeveloped coast, 18.5 kilometres long, which is reserved for the Australian Defence Force Proof Range and Experimental Establishment; it extends from north of Port Parham to south of Port Wakefield. This area has a public exclusion zone which extends beyond the tidal flats into the waters of Gulf St Vincent.

Much of the Samphire Coast's intertidal flats fall within the 971-km² Upper Gulf St Vincent Marine Park. This Park includes the coast up to the median-tide line and waters of Gulf St Vincent, north of a line joining Parara Point and the northern end of Port Gawler Beach. The Lower Yorke Peninsula Marine Park is located around the 'heel' of the Yorke Peninsula, from Point Davenport Conservation Park to Stansbury, covering an area of 874 km². Troubridge Island, located within the Lower Yorke Peninsula Marine Park, provides feeding and roosting sites for a large number of shorebirds.

Land adjacent to these protected areas include private parcels and foreshore reserves, and these receive varying levels of protection. Though some are subject to disturbance and degradation of habitat, mainly from off-road vehicles. The potential impacts on important shorebird areas are greatest in these unprotected areas. If viable populations of shorebirds are to be maintained, protected areas and threats from adjacent unprotected areas require careful management.

In 2012 the Adelaide and Mount Lofty Ranges Natural Resources Management Board and BirdLife Australia commenced the Samphire Coast Icon Project, supported by funding from the Australian Government's Biodiversity Fund. This project is being undertaken in collaboration with the Department of Environment, Water and Natural Resources, BirdLife Australia and community and local government stakeholders. The Samphire Coast Icon Project seeks to improve community stewardship for the samphire and shorebird areas, and provide a framework to boost strategic efforts across agency, local government, community and industry partners to address the long-recognised need to ensure the conservation of this area for the future. The project aims to increase capacity to implement priority actions identified in the Metropolitan Adelaide and Northern Coastal Action Plan as well as further implement actions to support the Australian Government's Wildlife Conservation Plan for Migratory Shorebirds developed under the Environment Protection and Biodiversity Conservation Act 1999.

Project outcomes include:

- Improved conservation and rehabilitation of nationally threatened samphire species and migratory shorebird roosting and feeding habitats.

- Assessment and trialling of samphire and saltmarsh rehabilitation techniques.

- Implementation of priority on-ground works to maintain and rehabilitate threatened coastal samphire and shorebird habitats identified in the Coastal Action Plan, Shorebird Population Monitoring studies and Estuary Action Plans, and local action to implement the national Wildlife Conservation Plan for Migratory Shorebirds and conserve regionally threatened coastal butterfly habitats.

- Coordination of strategic efforts across agency, local government and community and industry partners for coastal habitat conservation.

- Development and trialling of habitat retreat strategies to maintain coastal samphire and shorebird habitat.

- Assessment of significant artificial wetlands to scope and trial habitat modifications to optimise benefit for migratory shorebirds.

- Implementation of community stewardship and awareness initiatives to increase public knowledge and appreciation of saltmarsh and migratory shorebird habitat.

- Liaison with key mining industry partners (salt and shell grit) to scope and (where possible) undertake optimisation of mining lease areas for the benefit of shorebird habitats.

- Contribution to the East Asian Australasian Flyway Network site nomination.

In-kind contribution and funding from the Adelaide and Mount Lofty Ranges Natural Resources Management Board also covers Department of Environment, Water and Natural Resources / Natural Resources, Adelaide and Mount Lofty Ranges staff and Local Government hosted coastal officers, hosting, and some site works and additional shorebird conservation works such as the regional Shorebirds 2020 and Beach-nestingNesting Birds projects.

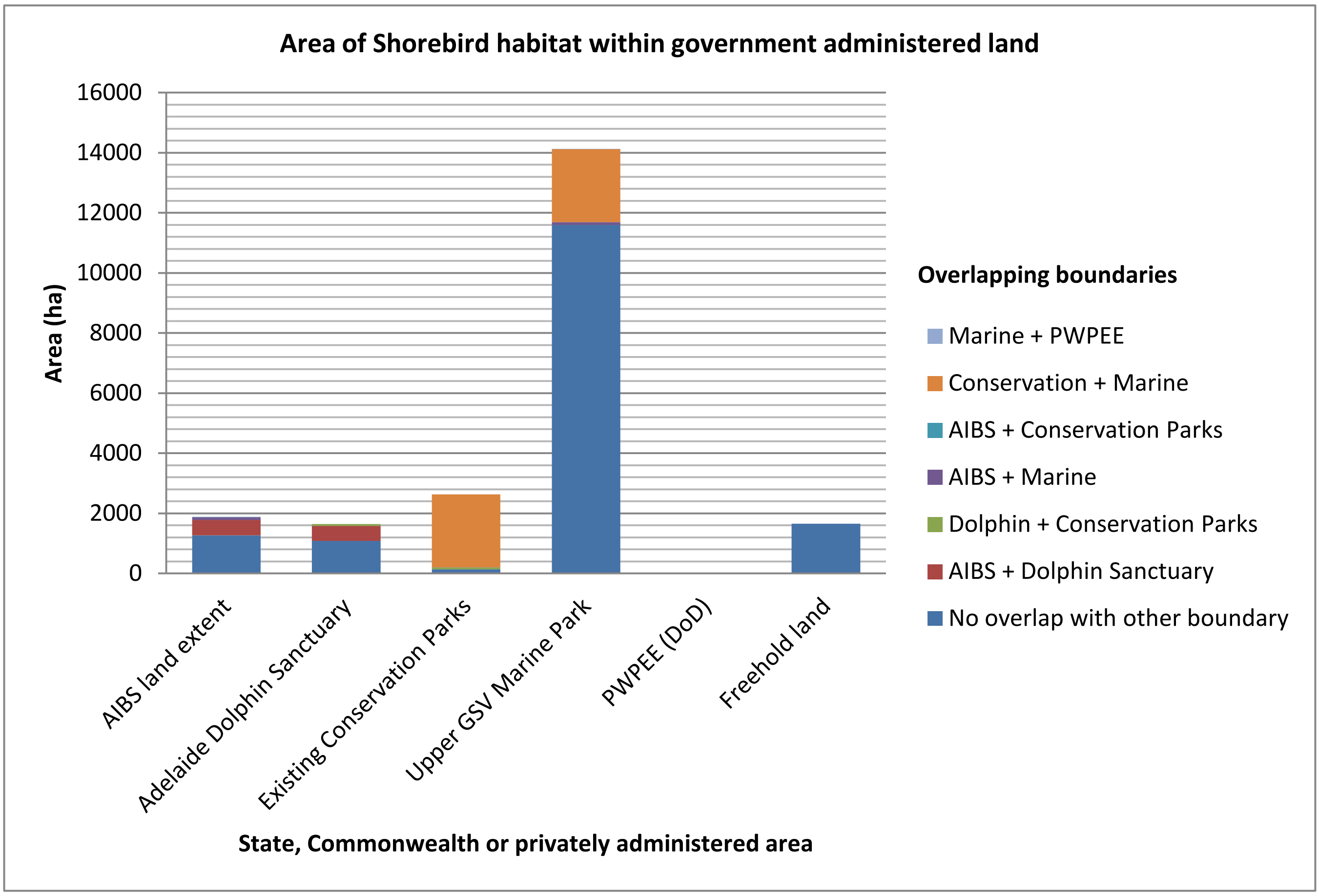


Figure 3. mapped shorebird habitat included in currently gazetted protected areas.

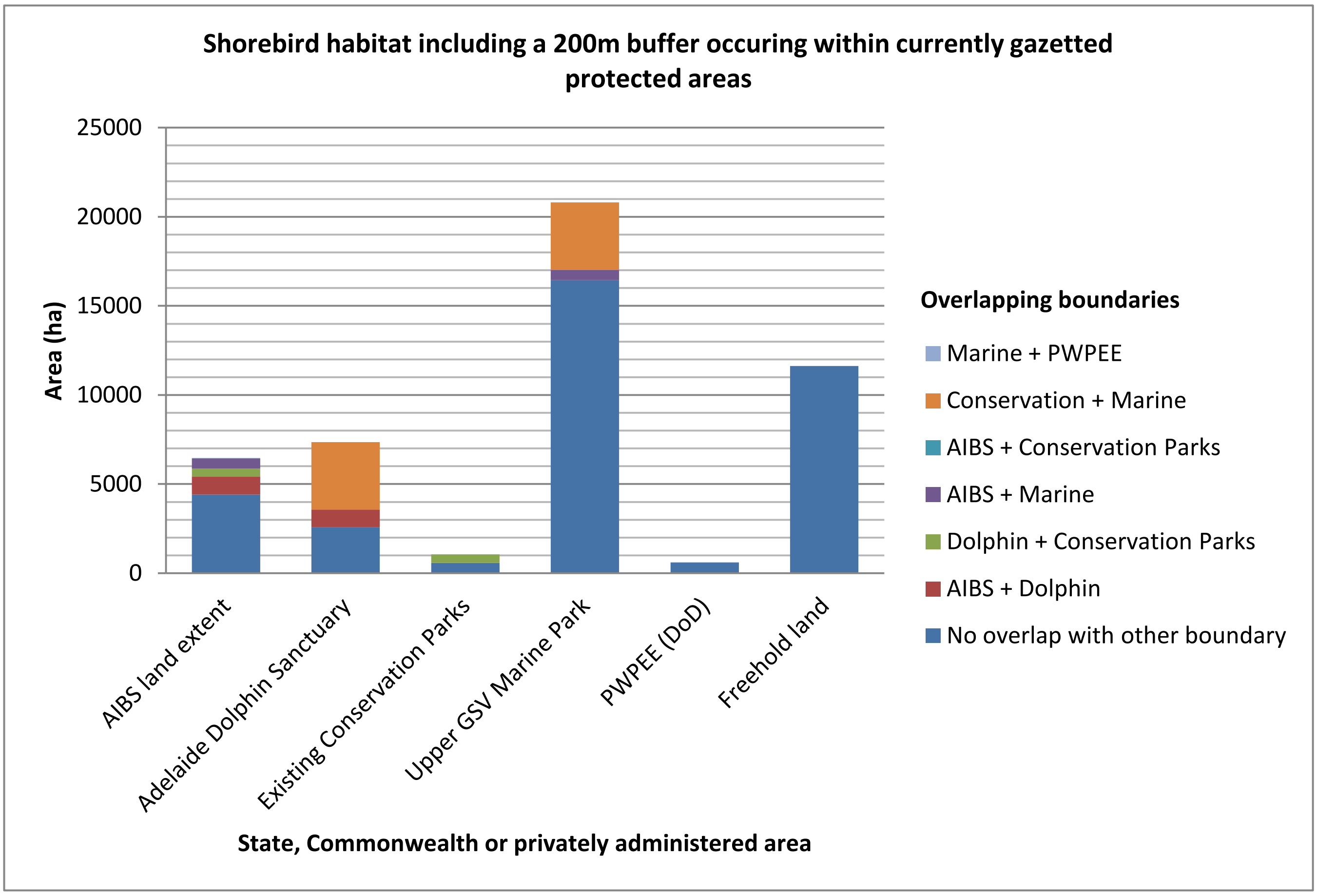


Figure 4. Mapped shorebird habitat including a 200m buffer included in currently gazetted protected areas.

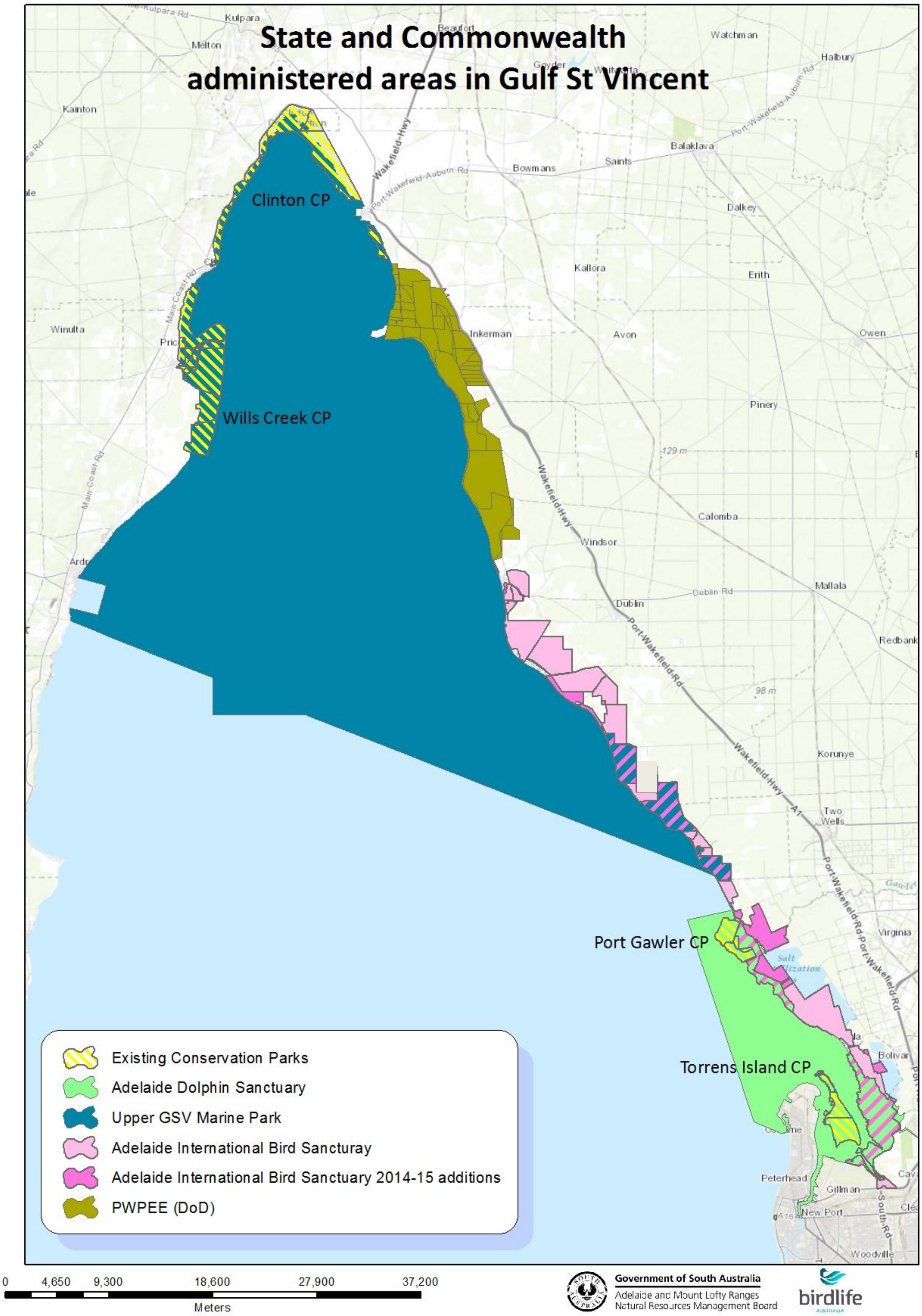


Figure 5. State or Commonwealth administered areas in Gulf St Vincent which overlap with shorebird habitat.

Key shorebird habitats in Gulf St Vincent

The coastal wetlands of Gulf St Vincent consist of a mosaic of artificial and natural shorebird habitats. The suitability and selection of roosting or feeding habitat by shorebirds is governed by ambient factors, including environmental, human, structural and abiotic features (Purnell et al 2010). It is important to determine the extent to which these factors affect the use of various habitats and the associated implications for shorebird habitat protection, so that conservation strategies and informed management of human recreational use of these habitats can be formulated (Peters & Otis 2007; Oldland *et al*. 2008).

Six broad categories of habitat type have been identified as being of priority conservation value for the protection of shorebirds in Gulf St Vincent and mapped (see Purnell *et al*. 2012). They are: tidal flats; sandy shores; saltmarsh; saltpans; commercial saltfields and freshwater wetlands. These sites are used according to temporal variations in prey abundance, tide conditions, local weather and hydrology, human interference and the diversity and abundance of the shorebirds themselves. The availability and proximity of these feeding and roosting habitats to each other is another limiting factor to use and can contribute immensely on the final fitness of a bird upon departure. It has been calculated that for every extra kilometre that a bird has to commute between roosting and feeding sites energy expenditure increases 1.3% (van de Kam et al 2004).

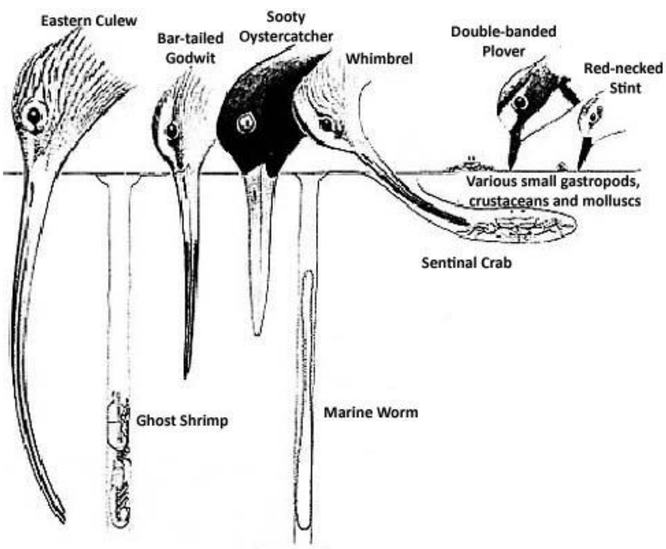


Figure 6. Shorebird bill adaptations to feeding in substrate (Illustration by Jeff Davies from Lane & Davies, 1987).

When considering shorebird conservation there are a number of habitat requirements which dictate where birds feed, roost and, in the case of residents, breed (Section 1.01e) Purnell et al 2010). Habitat requirements, tolerances and preferences vary between species and can be dependent on water depth, salinity, substrate and food source (Purnell et al 2015). Some species like the Sharp-tailed Sandpiper can be found in most wetland habitats, while others like Red Knot have very specific requirements. These requirements seek to maximise energy intake and minimise unnecessary energy use. A detailed matrix of habitat preferences for shorebird species occurring in Gulf St Vincent can be found in BirdLife Australia 2014 - *Dry Creek Saltfields Shorebirds Values Matrix*. Habitat requirements of threatened species are also discussed in Section 2.4

Detailed mapping of shorebird habitats to each documenting spatially explicit detail on habitat types and use in Gulf St Vincent, will be provided in association with this report. Although polygons in the shorebird habitat mapping layer give no weighting to abundance or diversity of shorebird species when overlayed with habitat and ecosystem mapping detailed in Coleman 2009, certain patterns in shorebird distribution and habitat use are evident (Figure 7).

Excluding the transitioning habitats of the Dry Creek Saltfields (Section 1.01k), the mapping identifies that the mudflats (primarily those between Light Beach and Ardrossan) provide the most feeding habitat. Sabkahs (Section 1.02d) are utilised throughout the tide cycle for both feeding and roosting and embankments are used exclusively for roosting. It is important to note that there is varying value in habitat both between habitat types and within habitat types. For example not all tidal flats provide productive foraging and when they do only a handful of species may utilise them and a smaller subset of these species may roost in the shallow waters when the tide is up. The relative value and prioritisation of these sites is documented and will be provided in an annotated guide which will supplement this report. Summaries of the broad habitat types and how they are used by shorebirds are explored in this below.

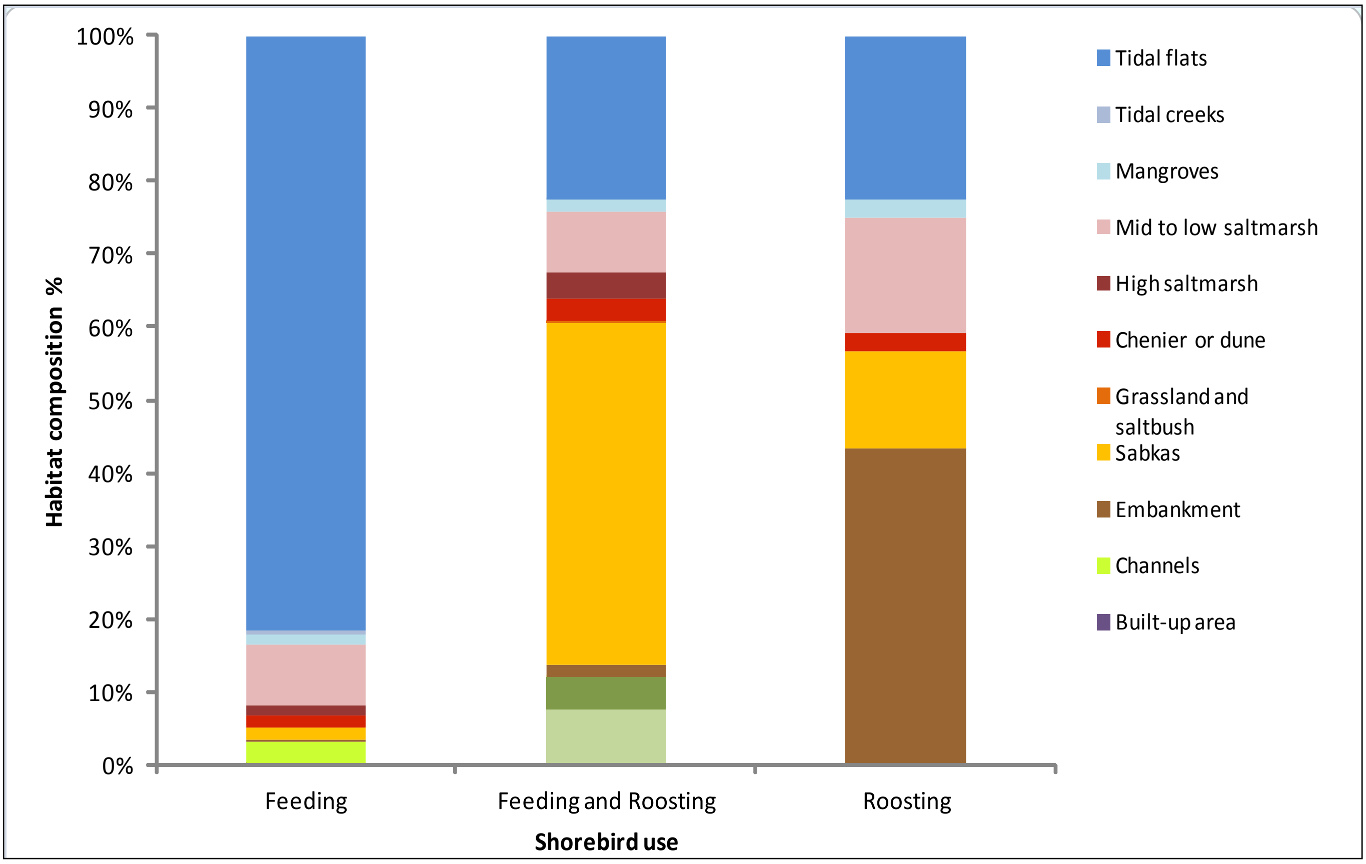


Figure 7. Proportions of habitat type use by shorebird in Gulf St Vincent derived from the overlap of shorebird distribution (BirdLife 2016) and habitat layers (Coleman 2009). Given continuing changes in habitat (salinity, structure etc) at the Dry Creek Saltfields since 2013 salina habitats have been excluded from this summary.

g) Tidal flats and creeks

A combination of sediments, currents, low relief and tidal range can produce large areas of tidal flats. In Gulf St Vincent, these factors have combined to form large expansive areas of tidal flats, such as those between Barker Inlet and Clinton Conservation Park, where the tidal flats stretch for nearly 100 kilometres, some of them are more than 250 metres wide.

The sand flats and mudflats which occur along Australia's coastline are inhabited by abundant and diverse small burrowing invertebrates. These benthic bivalves, worms, snails and crustaceans can be difficult to find, let alone catch, but shorebirds are expert at obtaining them (Figure 6). Accordingly, they are the most commonly seen birds on tidal flat systems around Australia.

In Australia, fourteen of the most regularly occurring shorebirds, including species such as Red Knot, Bar-tailed Godwit and Eastern Curlew, specialise in feeding on tidal flats. These species, all of which occur in Gulf St Vincent, have evolved to exploit different food sources within tidal flats and feed almost exclusively in those habitats during the non-breeding period. Due to the vertical stratification of benthic invertebrates found in intertidal substrates, large densities of several species can coexist in the same area without competing for prey. This resource partitioning is mirrored in several tidal and supratidal habitats mentioned throughout this section.

Significant areas of tidal flats in Gulf St Vincent support an array of invertebrates that are regularly eaten by shorebirds. Studies investigating intertidal benthic fauna at four sites on the eastern shoreline of Gulf St Vincent (Section Bank/Bird Island, Thompson Beach, Middle Beach and Port Gawler) revealed high species diversity across the board. Molluscs, annelids and crustaceans accounted for the majority of the 90 taxa found with the highest diversities occurring at Section Bank (Dittmann *et al*. 2012). However, abundance of benthic invertebrates was low and varied significantly depending on the site, taxa and season. Pronounced variance in large and small-scale spatial and temporal distribution patterns throughout the sites highlights the importance of maintaining a network of potential shorebird feeding sites.

Figure 8. Over 2,000 shorebirds including 977 Red Knot (EN) 48 Bar-tailed Godwit (CE/VUL) and 23 Curlew Sandpiper (CE) were counted roosting on tidal wrack at Pt Prime in the January 2016 count. Photo: Chris Purnell

Figure 9. The island of wrack at Pt Prime. Neamap

North of Light beach accumulations of tidal wrack form islands which can stretch up to a kilometre into the mudflat and can remain accessible for feeding and roosting throughout the tide cycle. The largest such accumulation, found at Pt Prime, covers over 165ha and can provide novel, secure habitat for several thousand shorebirds[2] (Figure 8Figure 9). Due to the softness of the underlying sediment and the ability of the mats to float these extensive areas are inaccessible to any terrestrial predator and remain free from the disturbance caused by crabbers in areas of coastline to the north.

h) Sandy shores

Much of Australia's coastline comprises beaches, consisting of predominantly sandy shores of varying steepness and width. Beaches often occur on high-energy shorelines, and they may support fewer burrowing invertebrates than tidal flats. Nevertheless, they provide a diversity of prey for a few species of shorebirds that specialise in foraging in these habitats. For example, species such as Ruddy Turnstones and Red-capped Plovers are adept at picking invertebrates from the tidal wrack of decomposing seaweed that is washed up on some beaches.

In general, shorebirds occur in low densities in these habitats, with the exception of high-tide roosts where large flocks of shorebirds sometimes congregate. Such large flocks usually occur when the expansive flats are covered by the high tide, forcing birds to rest in open areas (with unobstructed views) that have not been inundated.

Some species of shorebirds, such as the Hooded Plover and Red-capped Plover, are true ocean-beach specialists, foraging and nesting on beaches. They are less numerous than many other species of shorebirds, and a beach supporting only a few pairs may be of considerable conservation importance.

Sandy beaches often experience intensive recreational use, with some coastal parks hosting millions of visitors each year. However, few Australians consider beaches to be important habitat for wildlife and, as a result, the impacts that coastal development, exploitation, modification and recreation have on shorebirds on beaches are often overlooked. If this trend continues unabated, many areas that are currently considered good habitat for shorebirds could be rendered unsuitable.

Although vast stands of mangroves line the coast between Barker Inlet and Light Beach, most of Section Bank/Bird Island consists of sandy shores. Sandy shores occur from Light Beach north to Bald

[2] Counts of the Port Prime wrack island can only be completed from the shore. Due the size, undulating topography and colour/texture of the wrack island it is considered that official counts may underestimate the taotal population of shorebirds using the area.

Hill, where they form the dominant intertidal buffer between tidal flats and saltmarsh. They are often covered in thick layers of beachcast sea grass. Novel feeding opportunities for small surface feeding waders, such as plovers and Turnstones, occur in these areas.

i) Saltmarsh

Characterised as a mostly treeless plant community comprising a mosaic of low succulent shrubs and herbs, salt-tolerant grasses and sedges, saltmarsh is considered by some to be a lifeless wasteland. As a result, many saltmarshes have been in-filled, used as rubbish tips and places for recreational off-road vehicles (DECC 2008). Ignorance of the ecological value of saltmarsh has been reflected in the relative lack of protection afforded to the habitat when compared with most other ecosystems. Until recently, saltmarsh was the least studied of all of Australian marine habitats, even though the habitat occupies up to 16,000 km^2 of the Australian coastline and supports more than three times the number of vascular plant species than occur in mangrove forests (Saintilan & Williams 2000). There are 1,270 km^2 of coastal saltmarsh in Gulf St Vincent, comprising 600 km^2 along the eastern side, 200 km^2 at the head of the Gulf and 470 km^2 along the western shoreline.

Figure 10. Sharp-tailed Sandpipers roosting amongst samphire in the tidaal creek areas adjacent to Dry Creek salinas. Photo Chris Purnell.

Migratory and resident shorebirds feed and roost in saltmarshes, and in the absence of freshwater wetlands they are the preferred habitat of species such as the Common Greenshank, Marsh Sandpiper, Black-winged Stilt and Pacific Golden Plover. These sites are especially crucial during spring tides and other periods of high tidal inundation, when regular feeding and roosting sites are rendered unsuitable for most shorebirds. The birds are forced inland to feed or roost in saltmarshes and saltpans, such as those at Third Creek. Thus, with the threat of rising sea levels, these sites are valuable for shorebird conservation.

As with tidal flats, saltmarshes provide wide, open spaces which allow shorebirds uninterrupted views that provide increased surveillance for predators, enabling more time to be spent feeding. Some tidal creeks and runnels which criss-cross saltmarsh open up into large saltpans which may support large flocks of feeding or roosting shorebirds. Similarly, small, shallow pools and streams may also provide areas where shorebirds can feed while roosting.

Much of the destruction of coastal saltmarsh in Australia has occurred through reclamation for agricultural, industrial, transport and residential development (Kratochvil et al. 1972; Finlayson & Rea 1999). Significant alterations to the hydrology of saltmarshes have followed the construction of levees, culverts and floodgates, leading to the loss of ecological function and alteration of the floristic composition. The discharge of storm-water in coastal areas also alters regimes of salinity, increases nutrient levels and facilitates the spread of invasive weeds as well as the expansion of mangrove communities (Saintilan & Williams 1999). Similarly, unrestricted access into saltmarsh by walkers, cyclists, off-road vehicles and grazing animals also adversely affects saltmarsh communities. For example, wheel ruts from off-road vehicles and trail bikes persist for many years in saltmarsh, even after vehicles have been excluded (DECC 2008; see Threats to shorebirds in Gulf St Vincent, below).

Gulf St Vincent supports some of the most diverse saltmarsh communities in Australia and is part of the key remaining range of the threatened Bead Samphire *Tecticornia flabelliformis*, listed as Vulnerable in the Environment Protection and Biodiversity Conservation Act (1999) (EPBC Act) and National Parks and Wildlife Act (1972) (South Australia).

Subtropical and Temperate Coastal Saltmarsh was listed as a vulnerable threatened ecological communities under section 181 of the Environment Protection and Biodiversity Conservation Act 1999 in August 2013 (EC118) (05/08/2013) (TSSC, 2013).

The listing recognises adequate protection and appropriate land use practices are important to ensure the ecological community persists to benefit future generations. The listing under the EPBC Act does not prevent land managers from continuing land practices which were started before the EPBC Act came into effect, providing that the activity is lawful and not significantly intensified. However, national protection means new or intensified activities that may have a significant impact on the listed ecological community should be referred to the Australian Government Minister for the Environment for assessment.

The eastern coast of Gulf St Vincent supports fragmented patches of low-lying saltmarsh which are used by shorebirds. Further north, mangroves dominate the shoreline, and saltmarsh and saltpans of varying size and condition are bound by either mangroves or sandy shores on the seaward side, and, on the landward side, by higher land, ridges or development (Coleman & Cook 2009).

j) Claypans and sabkhas

Claypans are characteristically open and free of tall vegetation, and, like saltmarsh, they also remain vastly under-studied and under-protected in Australia. Formed in supratidal areas of low-lying, dry regions, they are seldom inundated by water (Coleman & Cook 2009). However, when they become covered with water, biofilms of cyanobacteria are able to grow, forming the basis of a food web in which shorebirds are the top predators. Recent studies of the feeding ecology of small sandpipers have revealed that some species, like the Sharp-tailed Sandpiper, may acquire a large proportion of their diet by feeding directly on biofilm (Kuwae 2010; Figure 11).

Figure 11. Sharp-tailed Sandpiper and Red-necked Stints feed on the wet cyanobacterial mats formed in the sabkhas north of Thompson Beach. Photo Dan Weller.

In Gulf St Vincent large areas of claypans from Dry Creek to Price provide valuable shorebird habitat. North of the Light River Delta claypans provide the predominant supratidal habitat for shorebirds. Although these areas are largely independent of tide and are only rarely inundated by rain events or spring tides, many regularly receive water through evaporative pumping. These habitats, known as sabkhas, form along arid coastlines when sea water filters through porous near coastal sediment and is brought to the surface through evaporation.

As with saltmarshes, the lack of tall vegetation and largely supratidal nature of claypans provide ideal roosting, feeding and breeding habitat and should be considered as a crucial refuge with the threat of sea-level rise (Figure 13).

Figure 12. Grey Plovers flocking in the supratidal claypans at Bald Hill. Photo - Chris Purnell.

Figure 13. The satellite track of a Grey Plover tagged at Thompson Beach by VWSG and Friends of Shorebirds SE for the AMLR NRM Board showing usage of inland roost sites.

k) Commercial saltfields

Though many migratory shorebirds inhabit intertidal habitats while they are in Australia, during their non-breeding season, their use of claypans indicates that supratidal habitats can also provide suitable habitat for wintering shorebirds.

In Gulf St Vincent, some of the most significant supratidal habitats are artificial ones. Of these, the salt evaporation ponds in the Dry Creek Saltfields has historically provided the greatest amount of shorebird habitat. Shorebirds commonly dispersed throughout 3,204 of the 4,307 hectares of ponds in Sections 2, 3 and 4 prior to decommissioning. Of these marine to high hypersaline ponds only shallow areas (<20cm) such as exposed banks, islands and levees were utilised for feeding and roosting[3]. This represents less than 15% of the total area of the operation.

Fine scale habitat mapping of the saltfields (Purnell 2011) has not been updated since decommission, due to the variation in habitat being lost and created, as result of the transition between active operation and holding pattern (further discussed in Section 1.02).

The presence of supratidal habitats can increase the number of shorebirds that a region can sustain, or reduce the detrimental impacts of the loss of intertidal habitats (Velasquez & Hockey 1992; Masero 2003; Dias 2009). A reduction in the area of intertidal foraging sites often results in an increase in the density of shorebirds in the remaining areas, which, in turn, leads to an increase in both the impact on shorebird food supplies and interference between foraging birds (Velasquez 1992).

The presence of supratidal habitats which resemble intertidal habitats, such as the Dry Creek Saltfields (Figure 15), can provide alternative foraging areas for shorebirds and other species of waterbirds (Weber & Haig 1996). Several studies have suggested that the availability of high-tide foraging areas contribute significantly to the maintenance of both high foraging densities of shorebirds on intertidal mudflats and overall stability of non-breeding populations (Velasquez & Hockey 1992).

Commercial saltworks are supratidal habitats managed for the production of salt. By the predictable manipulation of water depth and salinity used for salt production, these areas attract many species of shorebirds, as the fluctuations in water depth and salinity provide a variety of foraging habitats, each of which suits a particular guild of shorebirds. Because these artificial supratidal areas have salinity, fluvial dynamics and benthic substrates that differ from tidal communities, they support distinct invertebrate communities. Consequently, these habitats can provide both supplemental high-tide and preferential feeding habitats for different species of shorebirds (Masero *et al.* 2000).

Figure 14.Shorebirds and waterbirds congregate on pond XC3 at Dry Creek Saltfields. Photo Chris Purnell.

[3] Two common resident species, Banded Stilt and Red-necked Avocet are the exception to this statement as they regularly swim into deeper water to feed on invertebrates in the water column.

Figure 15. Several species of shorebirds thrive on the high densities of invertebrates, including clouds of Brine Flies *Ephydridae,* which occur in the hypersaline ponds of the Dry Creek Saltfields. Photo Chris Purnell.

Figure 16. Brine Shrimp *Artemia sp* and Fairy Shrimp *Parartemia sp* accumulated at the windward of a levee in high hyperdsaline pond XB8. Photo Chris Purnell.

Shorebirds represent about 25 per cent of the more than 200 species of birds recorded in and around the Dry Creek Saltfields. Since 1976, 52 species of shorebirds have been recorded in the region (including nine of them in numbers considered to be of international significance). Together with the Price Saltfields, these artificial supratidal habitats are a major factor in Gulf St Vincent being an important shorebird area in South Australia, second in importance only to the Coorong.

Importantly, these habitats are not readily accessible to the public and remain largely undisturbed, apart from occasional operational staff or birdwatchers (both of whom are aware of the implications of disturbance).

While shorebirds occur at varying densities across the salinity gradient, medium-high hypersaline ponds of Dry Creek Saltfields have traditionally supported the highest abundance and diversity (Day 2002, Purnell et al 2010, 201, 2012, 2013, Brett Lane & Associates 2014). A similar pattern occurs in in San Francisco Bay where densities of diving ducks decreased with increasing salinity while those of shorebirds increased (Stralberg et al 2003). Medium-high hypersaline (80–150 g l-1) ponds may be particularly valuable for many shorebirds and other species because of high densities of saline-tolerant invertebrates they support (Masero, 2003; Takekawa et al., 2006; Takekawa et al., 2009). As salinity increases species richness often decreases (Britton and Johnson 1987; Williams et al 1990) however overall biomass can increase up to high hypersaline conditions (Warnock 2013). In Dry Creek salfields medium-high hypersaline ponds, introduced Brine Shrimp *Artemia franciscana* Fairy Shrimp *Parartemia* zietzania (Figure 16), Brine Fly larvae and pupa *Ephydridae* sp and Chironomid larvae *Tanytarsus barbitarsis* represent an important food resource for species that exploit this type of prey. As in similar systems elsewhere (Takekawa et al., 2006), biomass in these ponds can exceed the combined macroinvertebrate biomass of other ponds by several orders of magnitude (Brett Lane & Associates 2014). Given abundance and their location (either suspended in the water column, on the water surface or accumulated on the shoreline) these prey items can often be consumed by birds at a high rate with little search time (Masero et al., 2000). However, Ephydra are likely to be preyed upon by many more species of waterbirds than are Artemia (Anderson, 1970; Takekawa et al., 2009). Fly larvae, pupa and adults are particularly accessible to shorebirds when prevailing winds accumulate them on the windward side of salinas.

l) Freshwater wetlands

Other supratidal habitats used by shorebirds include low-intensity aquaculture ponds, sewage treatment plants, stormwater detention ponds and natural ephemeral wetlands. In the Adelaide Mt Lofty NRM region the Greenfields Wetland complex, Buckland Park Lake and several mixed use wetlands throughout the Onkaparinga region have been identified as the priority shorebird habitats.

In late 2015 SA Water inundated two decommissioned ponds within the former Dry Creek Saltfeild with treated wastewater. The formerly hypersaline ponds PA 9 and 10 (46 and 14 ha respectively) (Figure 17) were filled with freshwater creating a slightly brackish habitat immediately utilised by waterbirds and several shorebird species[4].

[4] One shorebird count of Bolivaar ponds was conducted in coordination with Dry Creek counts (Section 2.3). Additional waterbird counts were conducted monthly by G. Carpetner between 10/12/2015 and 21/4/2016

Figure 17. Ponds PA9 and 10. Dry 31/12/2014 (left) and inundated 17/1/2016. Google earth

Figure 18. Ruff (left) and Sharp-tailed Sandpiper observed on pond PA9 in January 2016. Photo Chris Purnell.

In addition to providing ecosystem and anthropogenic services such as flood mitigation and nutrient filtration, these areas provide unique foraging, roosting and often breeding opportunities for shorebirds. As with saltfields, time spent in these habitats is not restricted by tidal fluctuation, allowing shorebirds to spend longer periods foraging (Velasquez & Hockey 1992; Weber & Haig 1996). These wetlands also provide an open, shallow freshwater habitat for shorebirds such as Wood Sandpipers and the Australian Painted Snipe (Endangered EPBC), which prefer feeding and roosting in freshwater or brackish conditions. North of Adelaide, stormwater wetlands (Barker Inlet Wetlands, Greenfields, Whites Rd Wetlands), the above mentioned SA Water wastewater ponds and the ephemeral Buckland Park Lake, represent the only semi-regular fresh-water sources in the coastal area .

Although prone to larger scale temporal fluctuations in freshwater availability these areas can support high densities of shorebirds and a variable continuum of available foraging habitat as water levels draw down (Purnell et al 2015).

Section 1.02 Conservation and threats to shorebirds in Gulf St Vincent

Listed migratory species are a matter of national environmental significance under the EPBC Act. As such, any action that has, will have, or is likely to have a 'significant impact' on a matter of national environmental significance will require approval. Substantial penalties apply for taking such actions without approval.

In Australia and the EAAF, many of the current threats are linked to the changing availability of wintering, stop-over and breeding habitats (MacKinnon et al. 2012). The loss of key locations at any point on the migratory pathway will have significant consequences for a number of species (Commonwealth of Australia 2015). While it is theorised that habitat loss in the Yellow Sea is the most significant driver of declining shorebird populations, there are a number of local threats which may be contributing to decrease fitness in non-breeding birds.

The Commonwealth of Australia's *Wildlife Conservation Plan for Migratory Shorebirds* identifies 11 threats that are likely to significantly affect shorebird populations adversely. These threats and their relative consequences and likelihood are listed in the threat matrix below.

Table 2. Migratory Shorebird Population Residual Risk Matrix listed in the Commonwealth of Australia's *Wildlife Conservation Plan for Migratory Shorebirds*.
http://www.environment.gov.au/system/files/resources/9995c620-45c9-4574-af8e-a7cfb9571deb/files/widlife-conservation-plan-migratory-shorebirds.pdf

Likelihood of	Consequences				
	Not significant	**Minor**	**Moderate**	**Major**	**Catastrophic**
Almost certain		• Harvesting of shorebird prey	• Coastal development in Australia		• Coastal development, particularly in the Yellow Sea*
Likely		• Hunting* • Fisheries by-catch*	• Anthropogenic disturbance • Altered hydrological regimes • Invasive species	• Climate variability and change	
Possible					
Unlikely		• Chronic pollution			
Rare or Unknown		• Acute pollution			

* threat occurs mostly outside Australia.

Threats to shorebird populations and their habitats in Gulf St Vincent can be classified under 5 categories:

- Human-induced habitat loss or degradation (including coastal development, altered hydrological regimes and climate change variability and change).
- Human disturbance.
- Invasive species.
- Human-induced mortality or breeding failure.
- Pollution.

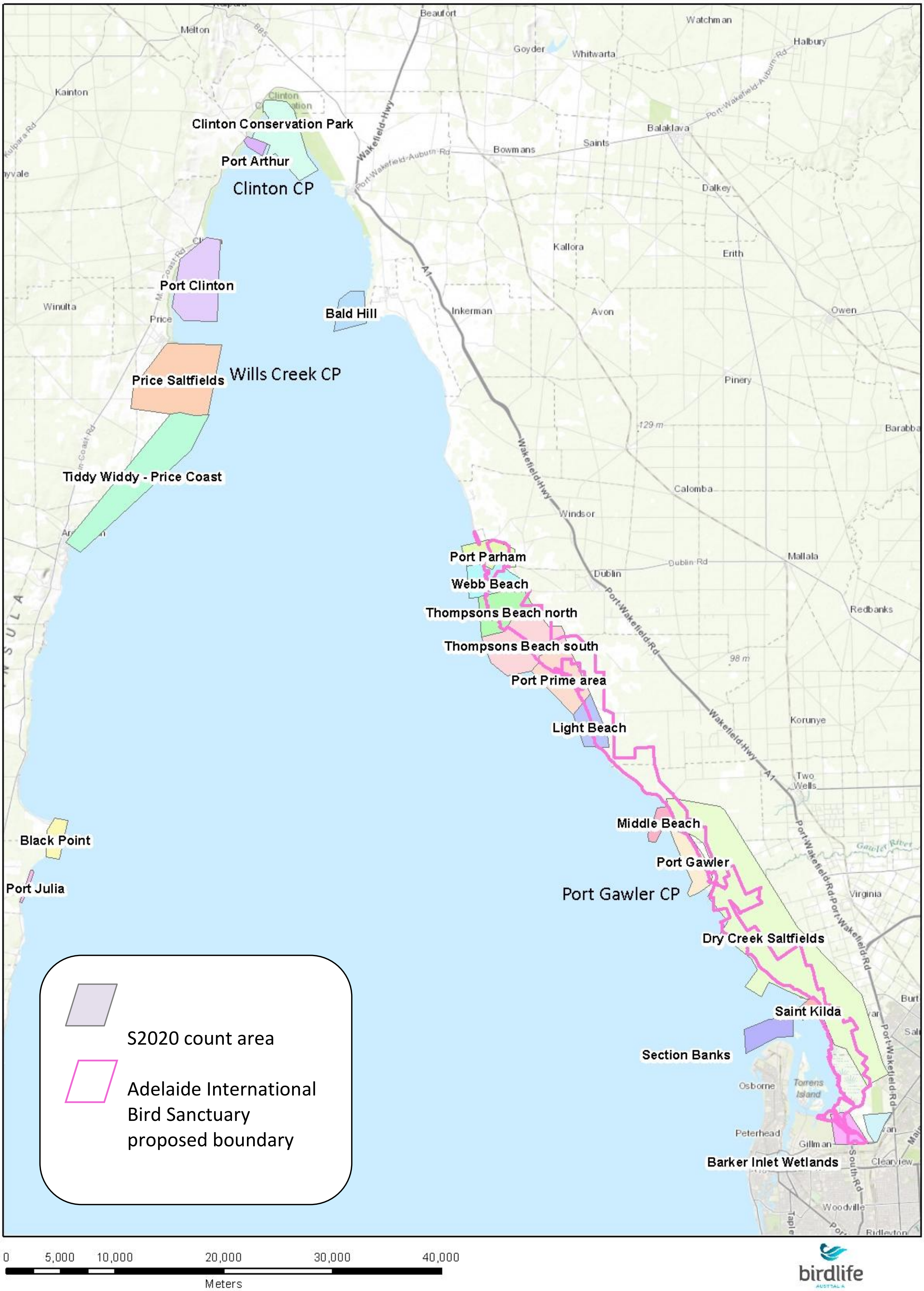
The relative consequence of these threats depends on the scale and cumulative effect of human actions throughout the area, and the degree to which shorebird populations are currently limited in the area. Previous reviews of wader populations in Gulf St Vincent have been limited by a shortage of data and are therefore subject to sampling error, and probable declines in shorebird numbers may also be attributed largely to factors independent of the Gulf (Close 2008). These conclusions are based on a 50 per cent decline in numbers (from 59,851 to 29,929) of Northern Hemisphere (or Palaearctic) breeding species recorded in Gulf St Vincent between 1979 and 2008. In contrast, resident species declined overall by only 12 per cent. However, within the category of residents, the number of Red-necked Avocets declined by 96 per cent, and numbers of Black-winged Stilts, Red-kneed Dotterels, Red-capped Plovers, Masked Lapwings and Banded Lapwings also declined greatly (Close 2008). The Shorebird Population Monitoring Program has recognised declines in both resident and migratory birds throughout south-eastern Australia (Gosbell & Clemens 2006; R. Fuller, unpublished data), and recommends that threats to local shorebird habitats must be identified.

The threats listed above are not mutually exclusive, rather shorebird population declines are considered to be driven by the cumulative impact of these threats. For the purposes of identifying of site based threats and management priorities, the Shorebirds 2020 program requests observers to document threats using a technique developed by the Western Hemisphere Shorebird Reserve Network (Table 3. Each “count area” is scored as a discreet site and the “scope of threat” is only based on what is considered to be average shorebird population utilising that site. The following section lists known and potential threats to shorebirds and shorebird habitat in Gulf St Vincent at a site based level. The maximum threat score from the five categories was reported, along with the sum of the five threat scores for each area. While this technique is subjective and results varied between counters, it allows comparisons between potential threats (Clemens *et al*. 2007a).

Table 3. Description of threats to shorebird areas and how threats were scored.

Types of Threats Identified and their Scores:	
Human-induced habitat loss and degradation	
Human-induced disturbance	
Invasive species/habitat loss or degradation due to natural causes (e.g. vegetation encroachment)	
Pollution (oil spills, runoff, or anything that changes soil texture, elevation, acidity, toxicity, turbidity, etc.)	
Accidental mortality (not including oil spills; primarily refers to direct or indirect mortality during breeding, such as crushing of nests by vehicles, people, etc.)	
Scoring:	
Likelihood of threat:	Timing Threat Score
Happening now/ Almost Certain	3
Likely	2
Possible	1
Unlikely	0
Scope of threat:	Scope Threat Score
Entire area/population (>90%)	3
Most of area/population (50–90%)	2
Some of area (10–49%)	1
Small area	0
Unknown	1
Severity of threat:	Severity Threat Score
Severe/very rapid deterioration (>30% over 10 years)	3
Rapid to moderate deterioration (10–30% over 10 years)	2
Slow but significant deterioration (1–9% over 10 years) or large fluctuations	1
No or imperceptible deterioration (<1% over 10 years)	0
Unknown	1
Overall impact of threat:	
Add threat scores for timing, scope and severity to get an overall score of the impact of each kind of threat	
Impact score for each threat: 8–9=high, 6–7=medium, 2–5=low, 0–1=negligible	

Shorebirds 2020 count areas



a) Habitat loss or degradation

Table 4. Shorebird count area threat scores; Habitat loss or degradation.

Count area	liklehood	scope	severity	Total	source of habitat impact
Whicker Rd Wetlands	1	1	2	**4**	uncertainty of sufficient freshwater input
Barker Inlet Wetlands	3	2	3	**8**	sections will be lost to the Northern Expressway
Magazine Rd	2	2	3	**7**	uncertainty of sufficient freshwater input
Bolivaar	1	3	1	**5**	uncertainty of sufficient freshwater input
White's Rd Wetlands	2	2	1	**5**	uncertainty of sufficient freshwater input
Saint Kilda	3	2	1	**6**	hard levees leave no room for habitat retreat
Section Banks	2	1	1	**4**	mangrove succession
Dry Creek Saltfields	3	2	3	**8**	altered hydrology
Port Gawler	3	2	1	**6**	intertidal habitat damage by ORV
Middle Beach	1	1	1	**3**	NA
Light Beach	2	0	1	**3**	sabkah ORV damage
Port Prime	1	0	1	**2**	sabkah ORV damage
Thompson's Beach S	2	0	1	**3**	sabkah ORV damage
Thompson's Beach N	2	0	1	**3**	sabkah ORV damage
Webb Beach	1	0	1	**2**	sabkah ORV damage
Port Parham	1	0	1	**2**	sabkah ORV damage
Bald Hill	0	0	0	**0**	NA
Port Arthur	0	0	0	**0**	NA
Clinton CP	0	0	0	**0**	NA
Port Clinton	2	2	1	**5**	hard levees leave no room for habitat retreat
Price Saltfields	1	1	1	**3**	contingent on continued commercial operation
Price coast (Mac's Beac	0	0	0	**0**	NA

Habitat loss and degradation is the prime long-term threat to migratory and resident shorebird populations in Gulf St Vincent. The urbanised stretch of coast south of Adelaide has historically supported healthy numbers of shorebirds, including breeding Hooded Plovers, but since extensive development, increasingly intensive use by people and altered hydrology and numbers of shorebirds in the area have plummeted (Close 2008) and beach-nesting birds, especially Hooded Plovers, have become increasingly uncommon.

This is the scenario now facing shorebird habitats north of Adelaide, with the projected population growth of the northern Adelaide region tipped to exceed 160,000 over the next 30 years. Apart from direct loss of habitat, it is the cumulative indirect effects that population growth has on shorebirds which will threaten populations in Gulf St Vincent. For example, large areas of tidal mudflats at St Kilda have been reclaimed and built upon, including a boat launch and marina. This has not only removed historic feeding and roosting sites and degraded surrounding habitats (Coleman & Cook 2003) but has also increased levels of disturbance from boat traffic, the occurrence of exotic predators and competitors, the potential for pollution and the introduction of coastal weeds.

When considering habitat loss or degradation on its own, there are three major management areas to consider:

- the Dry Creek Saltfields,
- Barker Inlet Wetlands,
- the Samphire Coast,
- Freshwater habitats (Buckland Park Lake and Greenfields complex).

i) Dry Creek Saltfields

The habitats that the Dry Creek Saltfields created as an active operation supported an average population of nearly 15,000 shorebirds.

Modified salt pan habitats have been available for shorebirds for over sixty years since the Dry Creek salt pans were established with Imperial Chemical Industries (ICI) commencement of salt production at Dry Creek in 1940. The primary aim was to supply brine for the manufacture of sodium carbonate and sodium bicarbonate on LeFevre Peninsula. Since the sale to Penrice Soda Products in 1989, the operation was sold to Ridley Corporation Limited in 2005, operated by Ridley's subsidiary, Cheetham Salt. More recently land has been sold on to Adelaide Resource Recovery / Buckland Dry Creek Pty Ltd (Hough 2008).

Maintenance of habitat condition at Dry Creek was contingent on continuous, active management of site water levels, however recent steps toward decommissioning the site have drastically altered the established salinity gradient and the shorebird prey communities which rely on it (Purnell 2014). The decommissioning process presents both risks (habitat loss or degradation) and opportunities (habitat creation or optimisation) for shorebird conservation. These are identified in a 2013 board funded *Risks and Opportunities* briefing paper (Coleman 2013) and their varying potential effects on shorebirds are further investigated in the discussion section of this report. The following summarises the decommissioning process to date and its effect on shorebird habitat.

As with several other sites in Australia, the Dry Creek Saltfields were managed for the production of salt by Ridley Corporation on a mixture of freehold and crown land under a 100 year mining lease. However in a statement from the Australian Stock Exchange (November 2012), Ridley Corporation announced the sale of "non-development potential saltfields" plus the Cheetham brand-name to a Chinese operator, CK Life Sciences. Ridley Corporation retained the saltfields at Dry Creek to service contracts with Penrice Soda plus several non-operational saltfields interstate. Ridley Corporation stated that it will actively pursue other development opportunities for the land north of the Dry Creek operations which are not utilised for salt production (Flaherty 2013).

A break of contract with Penrice Soda in June 2013 (ceasing the necessity for salt production and thus continued flow management) confirmed that Ridley Corporation would announce plans for decommissioning of the operation.

In this case The *Mining Act* (1971) dictates that mining lease land does not have to be returned to pre-lease conditions; rather, it must be returned in a state that is *fit for the proposed purpose of use*. The company's proposed use of freehold land will set any rehabilitation targets, however the

Before decommission, the saltfield operator is compelled to provide a Program for Environmental Protection Rehabilitation (PEPR) in compliance with conditions outlined by the *Mining Act* (1971). This document will detail the final closure outcomes to be agreed upon by the landowner, including rehabilitation standards and criteria as well as acceptance of any residual risks which may be implicit.

Given the Dry Creek Saltfields supports important habitat for birds listed as threatened and/or migratory species under the Environmental Protection and Biodiversity Conservation Act 1999

(EPBC) the ultimate management of that in the interim, PEPR development stage should seek to have no detrimental impact on these Matters of National Significance (MNES).

To this end Ridley developed a proposal for a “holding pattern” which was initiated in August 2013 however not approved by DIMTRE until March 2014. As discussed in the Purnell 2014 report, this period was preceded by several months where, having ceased pumping, no new water was entering the system (April- October 2013). The ensuing months of evaporation caused drastic changes in the salinity of ponds throughout high value conservation value areas in Sections 3 and remained at abnormal salinities until January 2014 when water (entrained months earlier) was able to replenish the ponds (Brett Lane & Assoc 2015, Coleman pers com, Purnell 2014). The salinity fluctuations in these ponds exceeded the ranges experienced during historic operations (Brett Lane & Assoc 2015) and were too great to sustain the established in-pond invertebrate communities (Coleman pers com).

During this period (August-November 2013) ponds on freehold land, namely XF2, XE4, XC1, XC2 and XC2S were dried. Active pumping and passive evaporation reduced pond levels and, particularly during the tail of the drying period, provided additional shorebird habitat as dead and dying, marine-adapted invertebrates became concentrated and more readily accessible. This increase in the available foraging area was however only temporary as residual moisture evaporated, substrate hardened and any infauna that was capable of surviving the hypersaline conditions became desiccated and perished.

Unseasonal rains in February 2014 promoted growth of cyanobacterial mats in XF2 and XE4 which attracted shorebird foraging in those ponds. These conditions remained throughout winter and maximums of 1,087 shorebirds (including 78 Critically endangered Curlew Sandpiper) were observed on XE4 in September 2014 (Figure 19) until the ponds dried again in October 2014 (Figure 20).

Figure 19. Shorebirds feeding in standing surface water on dried pond XE4 in September 2014. Photo Chris Purnell.

Figure 20. Transitional stages of change in pond XE4: a) Inundated- July 2013 b) Almost completely dry January 2014 c) Surface water collected after high amounts of rain February 2014 d) Dry October 2014 (NearMAP imaging).

The transitional phases of drying as part of the progression into an established holding pattern have continue to provide temporary habitat for shorebirds as pond levels drop and sandy banks are exposed. Pond by pond scale data collected by EBS on behalf of Ridley Corporation as part of ongoing investigations demonstrates how shorebirds are adapting spatially and temporarily to these alterations.

Whether intended or incidental these drying patterns have been advantageous to shorebirds however cannot be taken as evidence of sustaining in-pond quality in previously high value areas or relied upon as habitat in the future. By summer 2014/15 all the ponds that had been drained in late 2013 were devoid of shorebirds and waterbirds, however by this time XF1 (drained over a 4 month period in late 2014) provided additional temporary habitat and in February 2014, 311 waders recorded. These including Banded Lapwing and breeding Red-capped Plovers in and around damp substrate on the margins of water remaining in the levee borrows. Once dry and in the absence of summer rain events these ponds become functionally useless for shorebirds. Similarly several ponds in Section 3 (XA3, XC3, PA3-5) have been subject to fluctuating water and salinity. In the case of XA3 and XC3 (Figure 21) this has resulted in increases in suitable habitat however increases in salinity in pond PA4-5 may be responsible for declines in shorebird usage in those ponds.

As part of Ridley Corporation's[5] investigations, variables influencing pond ecology were being recorded. These included:

- Pond by pond bird count data
- Observations of bird behaviour (i.e. foraging or roosting).
- Food source information for selected ponds in selected months.
- Pond depth
- Pond chemistry including dissolved oxygen and salinity

The ongoing data will feed into an Adaptive (Risk) Management Plan to address unforseen impacts the holding pattern may be having on natural values, soil and water condition. A report in preparation will assess the impacts of the holding pattern against the expectations presented in the 2013 EPBC Self Assessment.

In early 2016 local company Adelaide Resource Recovery (ARR) acquired 5,500ha of the saltfield from Ridley Corporation. The company who own 120ha in neighbouring Wingfield conduct comprehensive recycling of construction & demolition materials into valuable resources and are operating the saltfield under the name Buckland Dry Creek (BDC) Pty Ltd. All relevant obligations applying to the original PEPR outlined during Ridley Corporation lease period have now been transferred to BDC. DEWNR Dry Creek closure project managers have engaged in initial discussions with BDC about future use, however beyond a note on a commercial feasibility into running a

[5] Investigations innovated by Ridley Corporation have now been taken on by new managers Buckland Dry Creek Pty Ltd (a subsidiary of Adelaide Resource Recovery).

reduced saltfield in sections 3 & 4 have not proposed any future works. BDC have allowed necessary continuation of relevant research to continue and continue to manage the site satisfactorily.

Figure 21. Reduced water levels in pond XC3 provide an increase in shallow, complex shorelines for 1,429 Red-necked Stint February 2015. Photo Chris Purnell.

♥

As discussed, the maintenance of habitat values for migratory and threatened species at the Dry Creek Saltfields are contingent on seasonal, active management of water levels on site, therefore decommissioning without appropriate environmental planning will significantly decrease the quality of the habitat and have an impact on species listed under the *EPBC Act*. Any change in operation thereby triggers the requirement for a referral to Department of Environment for assessment under the *EPBC Act* before any action is undertaken.

Planning for the Dry Creek Saltfields to maintain shorebird populations will rely on critical decisions on how to adaptively manage existing ponds to meet multiple ecological goals within the given financial parameters and a larger strategic framework. A cross-departmental Dry Creek Taskforce has now been assembled to oversee future planning for the site.

Figure 22. Pond C2 south ("Wader alley") (a) January 2012 (b) June 2014 (c) January 2016. Photos Chris Purnell.

A briefing paper, funded by the Adelaide and Mount Lofty Ranges Natural Resources Management Board (Coleman 2013), investigated possible outcomes and associated risks of several management scenarios for the Dry Creek Saltfields after closure. Some of the options presented include retaining ponds as detention and polishing ponds or for use in aquaculture, or remediation of the pondage area to tidal wetlands.

BirdLife Australia advocates that management of optimised ponds for the conservation of shorebirds should continue in concert with some level of tidal remediation and optimised polishing ponds, thus meeting a variety of ecological goals (shorebird, waterbird, samphire, intertidal and fish). The advantages and disadvantages of varying levels of the aforementioned solutions were further investigated in Purnell 2015.

As discussed (Section 1.01l)) an option for utilisation of ponds for treatment of wastewater has already been initiated by SA Water as a trial with immediate benefit. Tidal remediation trials have also been initiated on one of the seaward ponds. The University of Adelaide (UoA) and Department of Environment, Water and Natural Resources (DEWNR) undertook preliminary desktop and laboratory-based research on this option that suggested it could be feasible without creating unacceptable environmental risks. Administered by CSIRO and UoA's Adelaide Research & Innovation Pty Ltd and supported through the AMLR NRM Board's and BirdLife Australia's Australian Government ALMR Samphire Icon Project (Section 1.01f) the trial aims to restore tidal cycling to pond XB8A by the installation of a tidal weir. The changes in the sediment/subaqueous Acid Sulfate Soils (ASS), water quality, and hydrology in the pond will be assessed. These changes will be linked to additional assessment of vegetation and benthic invertebrate recolonization and ultimately vegetation and shorebird populations (University of Adelaide 2016).

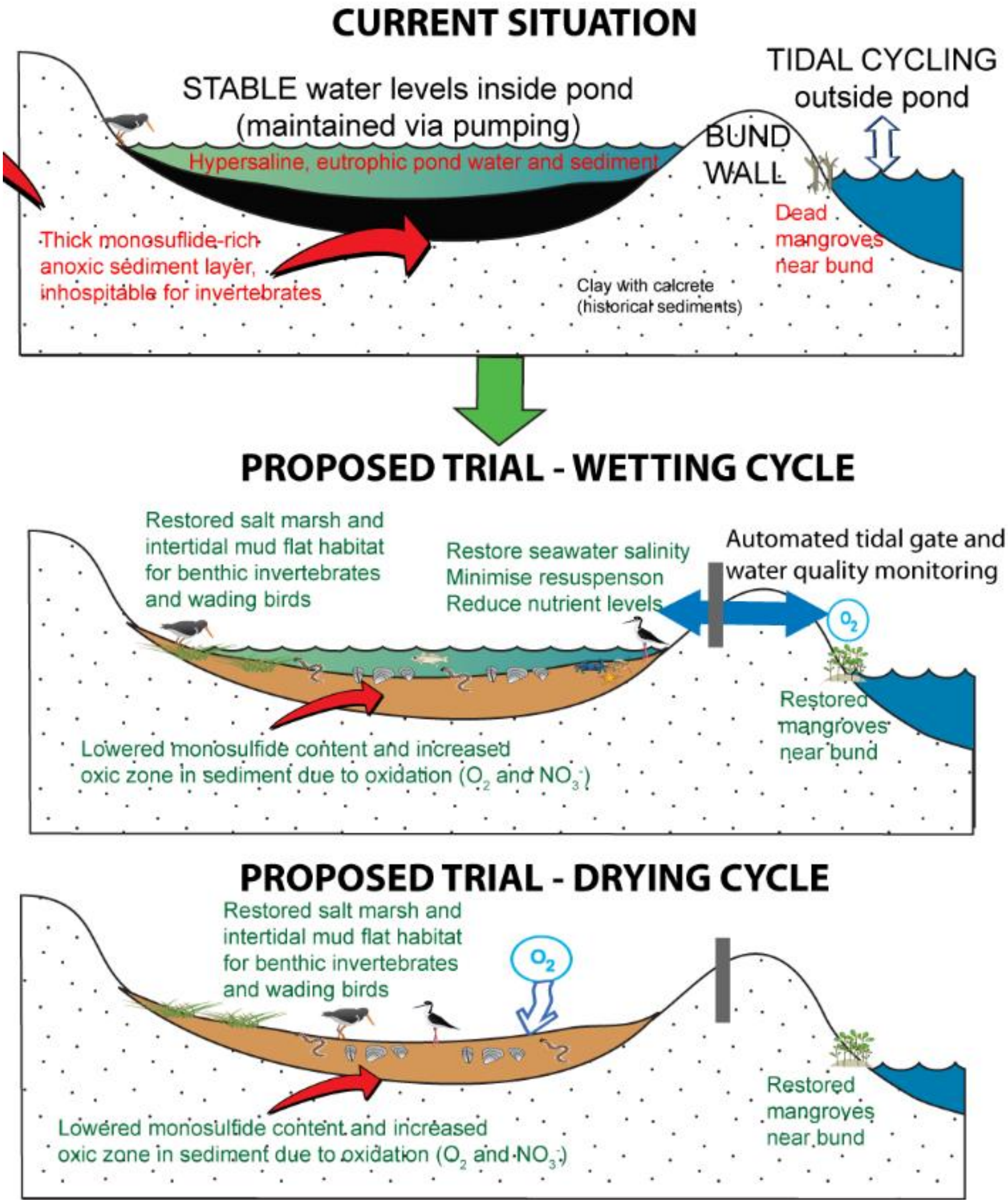


Figure 23. A conceptual model of the tidal inundation trial project showing hypothesised outcomes of the lower monosulfide concentration and benthic invertebrate and vegetation re-colonisation while minimising external environmental impacts (UoA proposal to DEWNR 2016)

ii) Price Saltfields

Commercial salt production by solar evaporation of seawater has occurred at Price since the Gulf Salt Co. Ltd began production in 1919 with the capture of seawater at high tide by a dam across Willis Creek. With a number of different owners since then the field has expanded to 1064 hectares of evaporators, crystallisers. A processing plant produces salt for industrial and household use (Hough 2008). With ongoing contracts for provision of salt, Price Saltfields continue to be managed as an active operation and supports annual average population of 7,500 shorebirds.

Table 5. Red Knot, Great Knot and Caspian Tern, Price Saltfield. Photo Chris Purnell.

iii) Barker Inlet Wetlands

The northern basin of the Barker Inlet Wetlands (north of Salisbury Highway), managed by Pt Adelaide Enfeld Council, comprise the final stages of stormwater treatment before being debouched into tidally influenced ponds which are connected through a single weir to the mangrove forest dominated estuary of North Arm Creek (Figure 24). The large terminal pond in the north east of the system provides the most abundant and valuable foraging habitat for shorebirds and is densely populated on falling and rising tides (Figure 25). The surrounding saltmarsh and tidal creeks support lower densities of marsh species throughout the tide cycle and are home to breeding Red-capped Plovers. The freshwater section of the wetlands provide novel habitat for freshwater and marsh species at low densities including breeding Red-capped Plovers, Black-fronted Dotterels and Black-winged Stilt.

The Barker Inlet Wetlands is the only notable shorebird habitat which will be effected by the footprint of the Northern Expressway development. Although a recent change in project management has altered the proposed footprint to reduce the amount of wetland habitat impacted, and the current tender plans do make more accommodation for the intertidal pond in the north east, there will inevitably be a net loss of available habitat. In addition to the physical loss of habitat project works are likely to impact on an area greater than the footprint of the final infrastructure. Additional impacts may include temporary hydrological changes, increased disturbance and dust pollution.

Project managers, Lendlease, have engaged in initial consultation with stakeholders including BirdLife Australia and have formed a Wetland Working Group to discuss the wetland aspects of the project to ensure the best biodiversity outcomes. This process proposes to include the allocation and future management of appropriate offset wetlands.

Figure 24. Barker Inlet Wetlands northern basin.

Figure 25. Black-winged Stilt, Red-capped Plover, Red-necked Stint, Sharp-tiled Sandpiper and Common Greenshank feeding and roosting in the tidal section of Barker Inlet Wetlands. Photo: Chris Purnell

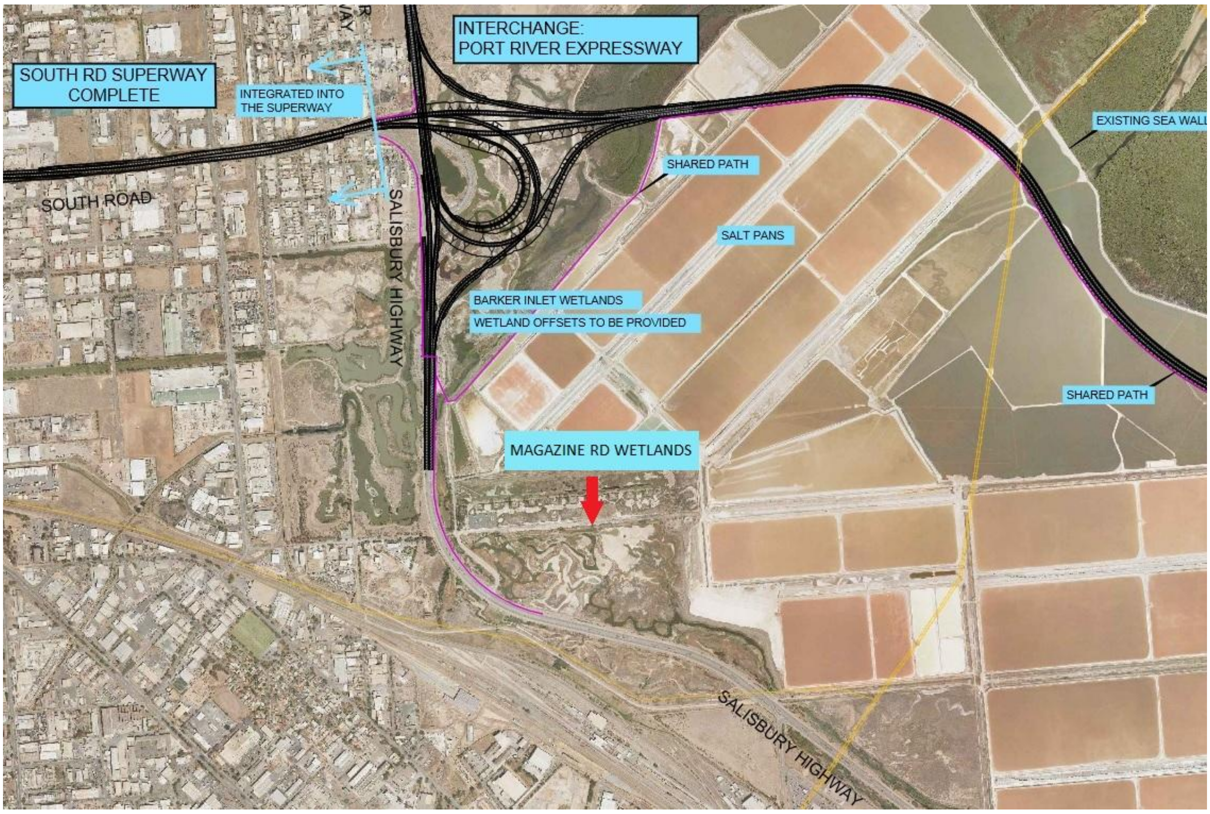


Figure 26. The proposed footprint of the Northern Expressway. Image adapted from the Department of Planning, Transport and Infrastructure South Australia proposal 2015 (now superseded by Len Lease proposed plan, August 2016).

iv) The Samphire Coast

Other notable shorebird areas along the Samphire Coast are susceptible to pressure from habitat loss or degradation. As previously discussed much of the priority shorebird habitat in this region has been included within the boundaries of the *Adelaide International Bird Sanctuary* and is thereby exempt from threat of habitat loss through development or inappropriate land use however an influx of off-road vehicles accessing areas of saltmarsh, intertidal flats and claypans, from Port Gawler to Port Parham, threatens to reduce the value of the habitats as feeding areas. Off-road vehicles can compact sediment and the benthic macrofauna contained within (Schlacher *et al*. 2008), drastically reducing the availability of prey for shorebirds. When driven in saltmarsh, four-wheel drives and motorbikes can also destroy the samphire flora and change the structure of the habitat (Section 1.02b)iii)).

Significant loss of intertidal habitat is also likely to occur through the effects of global warming. Since the early 1990s, southern Australia has experienced sea level rises of 2–7 millimetres per year (Edyvane 1999; Harris 2011) and it is expected that a further rise of more than 10 centimetres can be expected by 2030 (Clarke & Simpson 2010). Recent studies into the effects of climate change on shorebird habitat suggest that in the 21st century, sea-level rise will lead to the loss of a quarter of the habitat area used by waders, but will cause the overall population to decline by about two-thirds across 10 taxa because of the way the migration networks are structured (R. Fuller, unpublished data).

In Gulf St Vincent, this will cause beaches to recede by between 5 and 30 metres by 2050 (variation is determined by beach topography, supply of sand and movement of littoral sediment). Supratidal communities will be displaced by intertidal communities, and those that fail to migrate upslope will be lost (Caton et al 2009). The extent of potential loss of shorebird habitat and potential measure to mitigate against such losses are investigated in Coleman and Cook 2009, Clarke and Simpson 2010 and Purnell et al 2012. An increase in water temperature and the regularity of storm surges and turbidity resultant effects on sediment deposition and benthic communities are also likely to negatively impact the abundance and distribution of shorebird foraging habitat.

v) Freshwater habitats

As mentioned (Section 1.02 (l)) the Greenfields wetlands complex provide unique and favourable conditions for a number of freshwater marsh species. As it stands, plans for the Northern Connector will directly impact on the adjacent Barker Inlet Wetlands and may have implications for White’s Rd wetlands. This may increase reliance on the Magazine Rd Wetlands for shorebirds and waterbirds.

Given the site’s reliance on stormwater flows and available surface water runoff to provide adequate shorebird habitat, successive dry summers have precluded many species of shorebirds from using the ponds for months at a time during the October to March periods. When wet, the shallow ephemeral sections of the wetlands in the North West of Magazine Rd Wetlands are used by the highest densities and diversity of shorebirds however the same feature means they have a very low capacity to retain water (Figure 27). Providing an emergency allocation of water over a prolonged period (rather than a single large allocation) to these sites in October and again in January would ensure sufficient habitat in dry years. Such staged draw-downs are utilised at several non-tidal conservation ponds around Australia (Rogers et al 2014) to extend the period in which shorebirds can forage and reduce the likelihood that pond floors are colonised by vegetation (Purnell 2015).

Figure 27. Satellite imagery documenting the rapid drawdown of shallow ponds utilised by shorebirds at Magazine Rd Wetlands (top left). November 2014 (a), to January 2015 (b) and March 2015 (c).

The Washpool Lagoon, located south of the Aldinga Scrub Conservation Park at Aldinga Beach, is one of the last remaining coastal lagoons in metropolitan Adelaide. It is a seasonal coastal wetland lagoon that has been highly modified as a result of artificial changes to water levels and drainage patterns. As with the wader ponds in Magazine Rd the shallow depth of the Washpool Lagoon means it has a low capacity to retain water but fills rapidly with direct rainfall. The Washpool Lagoon wetland would be enhanced by damping the current peaks in flow. Reducing the size and prolonging the duration of inflows would reduce the probability of dry periods in winter and spring and increase the probability of flooding persisting into November and December. Any changes in water regime must allow the system to dry out in summer and autumn to maintain the vegetation structure and salinity balance of the current ecosystem (Ecological Associates, 2003). A Silver Sands Catchment Stormwater Management Plan is being developed by the City of Onkaparinga. This will outline environmental flow proposals and costing for actions to manage water in the Washpool and Aldinga Scrub.

BIRDLIFE AUSTRALIA RECOMMENDATIONS

1. Continue BirdLife involvement in strategic discussions with the Major Projects Working Group, the Dry Creek Task Force, Ridley Corporation and other potential stakeholders to ensure provisions for the shorebird population at Dry Creek after the withdrawal of Ridley Corporation.
2. Work to ensure the protection of the habitats that support shorebirds in Gulf St Vincent, including those along the Samphire Coast, as pristine, undisturbed places. This will include ensuring the appropriate ongoing management of afore mentioned protected areas administered by the state to maintain or improve their conservation values.
3. Ensure timing and extent of works on the Northern Expressway project are to have minimal impact on shorebird habitat in the tidal section of the northern basin of Barker Inlet Wetlands.
4. Continue monitoring of transistioning Dry Creek Salttfields habitats including trial areas XB8A and PA9/10.
5. Work with Flinders Ports and The Department of Planning, Transport and Infrastructure to secure Section Banks (Bird Island) as a protected area within the Adelaide International Bird Sanctuary network.
6. Investigate feasibility of supplying regular freshwater or stormwater flows to Buckland Park Lake to supplement degraded habitat at the adjacent saltfields.
7. Ensure that any future use of all or part of the Dry Creek site undergoes appropriate impact assessments and is subject to an official EPBC referral.

8. Encourage Adelaide Resource Recovery as custodians of the Dry Creek site to provide a mix of shorebird habitats site and optimise as much habitat as possible for shorebirds within the scope of the lands purpose (options further investigated in Purnell 2015). This may include a combination of the following:
   1) Reconnection of tidal prism to saltponds.
   2) Retaining a managed salt gradient in tidally independent salt ponds.
   3) Storm or waste water polishing and detention ponds

9. Ensure any changes to flows during the formulation of the closure plan are authorised and undergo appropriate impact assessments and are subject to EPBC referrals as a controlled action.

10. Ensure works to reengineer pond flows to a sufficient state to provide sufficient ecological value to support the existing shorebird population.

11. Protect existing samphire retreat zones by using planning or other measures and provide additional, adequate areas for samphire retreat (Coleman & Cook 2009: Action 2.5, 2.7).

12. Ensure offsets provided for the Northern Connector are equal to or greater in ecosystem value to the areas being impacted. Investigate further options for the Section 2 Ponds of Dry Creek saltfields to be converted to freshwater wetlands (stormwater or wastewater treatment) or alternatively restore tidal influence.

13. Complete construction works in months April to September to reduce impacts on migratory shorebirds, breeding resident species and EPBC listed threatened species (Australasian Bittern)

14. Where development is approved in near-coastal areas and an allowance for floodwater to escape to the sea is required, allow additional width for the flood-escape routes, over that required to handle the 1:100 year ARI flood event, to provide area for shorebird habitat and a path for landward migration of saltmarsh (Coleman & Cook 2009: Action 2.7).

15. Work with councils and planners to ensure storm-water wetlands are managed in a manner sympathetic to shorebirds' needs, taking into account the necessity for open, unvegetated areas for feeding and roosting and a dynamic regime of inundation.

16. Develop strategies that facilitate cooperative cross-jurisdictional planning which is required to limit the likely cumulative impacts of increasing urban growth in the region.

17. Incorporate shorebird-area spatial layers and attributes into existing spatial-planning layers, such as the environmental significance overlays, so that shorebirds can easily be incorporated into the planning process.

18. Ensure that a rigorous assessment is conducted for any planned activity or development that is likely to impact within 200 metres of important shorebird areas (including secondary impacts).

19. Protect existing samphire retreat zones using planning or other measures, and provide additional, adequate, area for samphire retreat (Coleman & Cook 2009: Actions 2.5, 2.7).

20. Open or partially-open tidal crossings restricting tidal flows in stranded saltmarshes (Coleman and Cook 2009).

21. Investigate options for the feasibility of shorebird- and waterbird-based eco-tourism to increase the economic and community value of conservation actions. Develop national and international partnerships with established initiative locally and internationally (case studies detailed in Purnell et al 2013 and 2015)

b) Disturbance

The largest ongoing threat to the survival of migratory shorebirds in Gulf St Vincent is disturbance. As Adelaide grows, increasing numbers of people are likely to visit the coastal and wetland habitats used by shorebirds particularly during the summer months. This threat is likely to escalate if thoughtful, adaptive management of recreation is not applied.

Table 6. Shorebird count area threat scores; Disturbance.

Count area	liklehood	scope	severity	Total	source of habitat impact
Whicker Rd Wetlands	2	1	2	**5**	recreational use, dogs
Barker Inlet Wetlands	3	2	1	**6**	construction activities
Magazine Rd	2	1	1	**4**	recreational use, dogs
Bolivaar	0	0	0	**0**	NA
White's Rd Wetlands	2	2	1	**5**	recreational use, dogs
Saint Kilda	3	2	3	**8**	recreational use, dogs
Section Banks	3	1	1	**5**	recreational use, dogs
Dry Creek Saltfields	1	1	1	**3**	potential for future visitor access
Port Gawler	3	3	3	**9**	recreational use, ORV, bait collecting, dogs,
Middle Beach	3	2	1	**6**	recreational use, ORV, bait collecting, dogs,
Light Beach	1	1	1	**3**	unauthorised access by ORV, recreational fisherman
Port Prime	3	2	2	**7**	recreational use, ORV, bait collecting, fishing, dogs.
Thompson's Beach S	3	3	3	**9**	recreational use, ORV, bait collecting, fishing, dogs.
Thompson's Beach N	3	3	3	**9**	recreational use, ORV, bait collecting, fishing, dogs.
Webb Beach	3	2	2	**7**	recreational use, ORV, bait collecting, fishing, dogs.
Port Parham	3	2	2	**7**	recreational use, ORV, bait collecting, fishing, dogs.
Bald Hill	1	1	1	**3**	recreational use, ORV, bait collecting, fishing, dogs.
Port Arthur	1	1	1	**3**	recreational use, bait collecting, fishing, dogs.
Clinton CP	0	0	0	**0**	NA
Port Clinton	2	2	1	**5**	recreational use, dogs
Price Saltfields	0	0	0	**0**	NA

Figure 28. Red-necked Stint (left) roost and Banded Stilt feed on the intertidal mudflats of Thompson Beach South as Crabbers patrol the edge of the tide. Photo: Chris Purnell

Studies have shown that human disturbance of roosting shorebirds is related to declines on local populations (Pfister *et al*. 1992; Tubbs *et al*. 1992; Burger *et al*. 2004), lowered body condition (Durell *et al*. 2005), regional habitat shifts (Burton *et al*. 1996) and local avoidance behaviour (Kirby *et al*. 1993). Species with high roost-site fidelity and minimal movement between roosts are most at risk from human disturbance and require particular attention (Rehfisch *et al*. 1996).

Occasional disturbance to shorebirds — such as those caused by the appearance of a raptor — are common, but generally there tends to be a balance between the energy lost during these natural periodic disturbances and the ability to offset those losses by foraging for longer or on supplemental prey. In an increasing number of areas, however, human disturbance appears to be too great to be offset by supplemental feeding (West *et al*. 2002). Modelling suggests that some patterns of disturbance can result in net energetic losses in habitats that remain occupied, and in some cases these energetic losses are greater than would have occurred if the habitat had been lost entirely (West *et al*. 2002; Rogers *et al*. 2006; Gill 2007). These energetic losses can potentially affect species at the population level, and the relationship between disturbance and population declines in non-breeding areas have been shown overseas in populations of the Pink-footed Goose (Tombre *et al*. 2005; Gill 2007). The level of knowledge required to determine conclusively to what degree disturbance may impact on shorebird populations is far from being met.

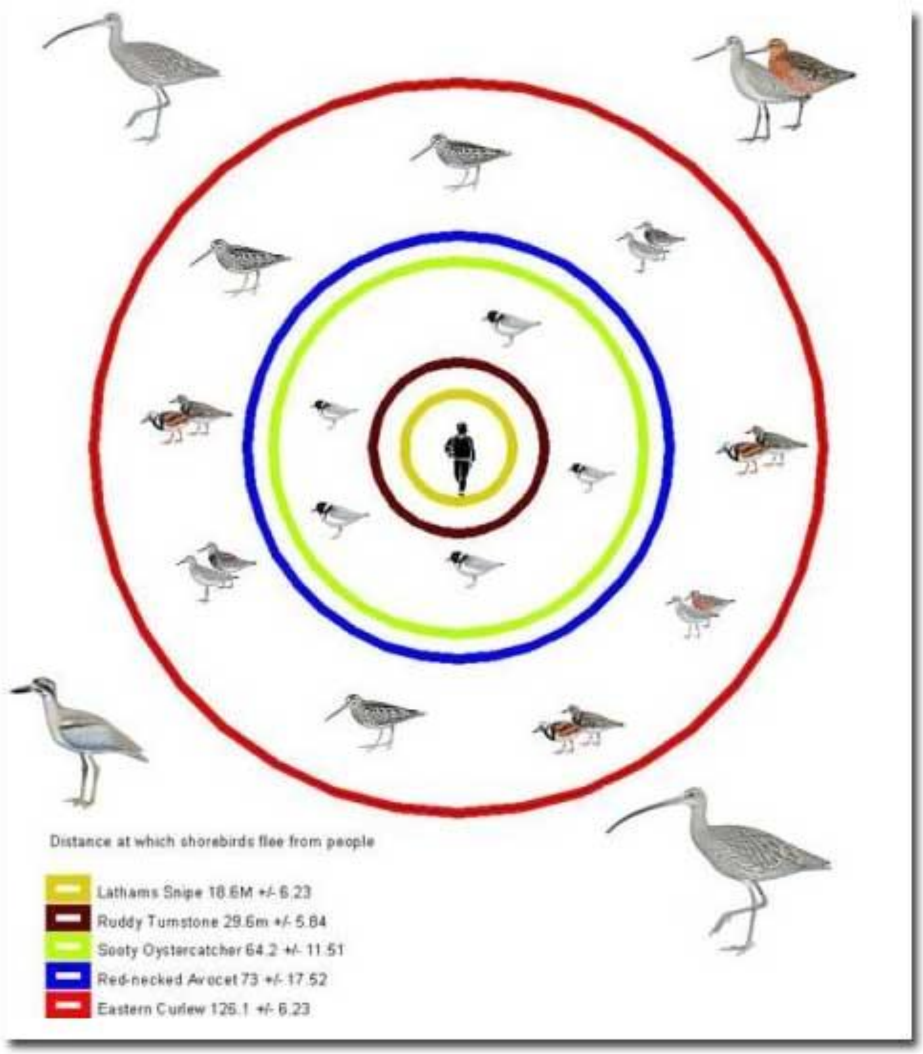


Figure 29. Each species of shorebird has its own tolerance to disturbance to human approaches. Distances given are from preliminary data, but further study may reveal larger buffers are required. (Illustration Jeff Davies).

A major complication in determining the impact of disturbance is the difficulty in determining the energetic cost of the wide variety of disturbances that may occur. Much work has been done to determine the distance at which different bird species flush when confronted with different kinds of disturbance, and results vary from 50 metres to 250 metres, with Eastern Curlews more likely to fly off at greater distances (Figure 29); most birds respond at greater distances to unleashed dogs or noisy and fast watercraft (Paton *et al*. 2000; Blumstein 2003; Yasué 2005; Gill 2007; Glover 2009). Unfortunately, this intuitive measure of disturbance probably underestimates the true energetic impacts of disturbance.

The shorebird habitat in and around much-visited Samphire Coast has been identified as the habitat most effected by disturbance. The frequency of disturbance necessary to cause shorebirds to abandon an area is unclear. It is clear, however, that disturbance has energetic costs that could potentially reduce a shorebird's chances of survival or its ability to reproduce. Pine Point, on the western shore of Gulf St Vincent, provides a good example. At this site, boats are continually launched by being towed by a tractor across shorebird feeding areas on the rocky reef and mudflat. The remaining edges of the tide line are patrolled by people catching crabs, many of whom are accompanied by dogs which constantly disturb feeding birds. It is difficult to gauge the effect of increased human activity on shorebirds over time without historic counts for these areas, but a comparison with similar undisturbed rocky reef or mudflat habitats at Black Point, 5 kilometres further south, shows a drastic difference. Although it receives limited disturbance, the small reef at Black Point boast one of the highest shorebird diversities in the Gulf, despite its remoteness in relation to other feeding and roosting areas.

i) Non-vehicular recreational activities

The most readily identified cause of disturbance to feeding and/or roosting shorebirds in Gulf St Vincent arises from non-vehicular recreational activities. These activities can be static (e.g. fishing, sunbaking, picnicking) or mobile (e.g. walking, jogging, crabbing, walking dogs).

Static activities may not initiate flight but can cause habitat avoidance and increased surveillance behaviour among feeding and roosting shorebirds. Alternatively, mobile activities are of lower temporal impact but have greater likelihood of initiating flight. Of these activities, dog walking, especially of unleashed dogs, causes the greatest levels of disturbance (see 'Dogs', below).

A steady increase in fishing/crabbing is also contributing to high levels of disturbance as well as the destruction of habitat around Gulf St Vincent (Fitzpatrick & Bouchez 1998). The upper sections of the Gulf provide important breeding and nursery areas for a number of key marine species, including King George Whiting *Sillaginodes punctata* and Blue Swimmer Crab *Portunus pelagicus*, both of which are fished recreationally and commercially. In particular, crabbing seasons coincide with the arrival of thousands of migratory shorebirds in Gulf St Vincent. The Blue Swimmer Crab season begins in September and runs through summer as the crabs congregate in inshore areas to breed, peaking in February; they then disperse back into deeper water by April. Hundreds of crabbers may patrol the tide line on a single beach, creating a constant disturbance for feeding and roosting birds. One popular crabbing technique, known as "dabbing", involves patrolling the tide line of shallow sandy beaches or mudflats. This overlap with shorebird habitat causes continual interaction and disturbance of feeding and roosting shorebirds. The alarming increase in the amount of crabbers visiting priority shorebird areas such as Thompsons Beach, in the last 2 years, has the added side effect of attracting an increase in dog and vehicle based disturbance and habitat destruction. Fishermen may also compete directly with shorebirds when collecting benthic invertebrates to use as bait (Carpenter 2008).

ii) Boating

Boating traffic is a major source of disturbance to shorebirds, and it has been linked to long-term abandonment of roosts (Burton *et al*. 1996). Red Knots, which occur in great abundance in Gulf St Vincent, have been recorded avoiding roosts in areas where high boating activity occurs within 1 kilometre (Peters & Otis 2007). Apart from feeding and roosting sites situated on sandbars adjacent to boating channels (Section Bank/Bird Island, Middle Beach and Port Wakefield), most shorebird areas in the Gulf do not currently receive high levels of boating traffic, but if the level was to increase it would reduce the number of coastal sites available for roosting by some species.

iii) Off-road vehicles

Off-road vehicle (ORV) use in the Samphire Coast occurs throughout saltmarsh, claypan and intertidal habitats. In addition to recreational driving of four-wheeled drives and motorbikes, ORV use is often associated with fishing/crabbing and illegal dumping activities as continuous stretches of sandy coastline allow access to remote areas and fishing sites (Figure 30). This disturbs roosting and feeding shorebirds, and potentially causes resident shorebirds to abandon their nests (Figure 39). The disturbance caused by four-wheel drives and dirt-bikes in roosting and feeding areas can have the same effects on shorebirds as habit loss, if levels of disturbance reach the point where the energy costs of surveillance behaviour and disturbance flights outweigh the energy gained from the habitat (West *et al*. 2002; Goss-Custard *et al*. 2006; Rogers *et al*. 2006; Peters & Otis 2007). If disturbance is sustained, shorebirds may abandon even the most productive of habitats, both within and across seasons (West *et al*. 2002; Goss-Custard *et al*. 2006). The use of off-road vehicles also has an impact on macrobenthic assemblages on sandy beaches (Schlacher *et al*. 2008).

Figure 30. Damage caused by ORV to the intertidal flat at Pt Gawler. Photos Chris Purnell.

Figure 31. Three primary activities linked to offroad vehicle use on shorebird habitat in Gulf St Vincent. a) recreational off-road driving (Pt Gawler), b) access to fishing or crabbing sites (Bakers Creek), site-seeing (Pt Prime). Photos Chris Purnell.

The closure of the Port Gawler Off-road Vehicle Park in late 2006 resulted in an increase in the number of off-road vehicles using shorebird habitat. In particular, dirt-bike riders regularly gain access to protected areas by flattening fences (Figure 32). These activities not only destroy habitat but also have create disturbance at inland roosts. Recently, the Off-road Park was reopened, attracting considerable attention from the dirt-bike and four-wheel drive community: a Facebook page run by the managers has attracted over 1,300 members. However, with a $40 entry price, limited opening hours (Saturday and Sunday), and no four-wheel drive facilities, there is still a large number of drivers using adjacent shorebird habitat in saltmarsh, most notably the Port Gawler intertidal foreshore. Off-road-vehicle drivers cause repeated disturbances, impacting on habitat quality and potentially causing accidental mortality to the two species of beach-nesting shorebirds that use the site. Research into the use of four-wheel drives in shorebird areas shows that only a small proportion (15 per cent) of off-road drivers heed signs asking them to avoid these sensitive areas (McGrath 2006). This problem has escalated due to the increasing affordability and accessibility of off-road vehicles. It should be noted that the increasing use of off road vehicles and related environmental impacts was raised in a 1977 Australian Government House of Representatives inquiry, yet little has progressed nationally to better manage these impacts (Australian Government 1977).

In March 2009, the South Australian LGA Executive Committee passed a motion requesting the LGA Secretariat organise a strategic workshop of key stakeholders on off road vehicle use. As a result of this motion, the LGA hosted a State wide forum in July 2009. The key theme for this forum was to examine the differing roles and involvement of respective organisations in assisting Councils in the management of vehicles on land under the care and control of Local Government (Sargent et al 2012).

A Local Government Land Access working group was established after the forum to address ORV access. The group consisted of Council representatives, South Australia Police, Department of Environment and Natural Resources, Natural Resources Management Boards, user groups and the Local Government Mutual Liability Scheme. A discussion paper was drafted in early 2012 to consider land access management and the legislative framework governing vehicles on public land. While the paper identified issues arising from off-road access, it also identified issues relating to overlapping jurisdictions making it difficult to establish any single solution that Local Government could adopt (Sargent et al 2012).

The paper noted that access of 'off road vehicle use' might be managed in 3 key ways:

- Prohibition of all vehicle access;
- Uncontrolled vehicle access; and
- Controlled vehicle access.

Suggested enforcement options include:
Establishment of Codes of Practice through community and representative user organisations;
Enactment of Council By Laws to enforce breaches of the Code of Practice (including appointment of authorised officers which might also include persons from representative jurisdictions); and
Enactment of State Government legislation to prohibit and/or control identified activities on Council land.

Following workshops on offroad vehicles at the 2010 National Coast to Coast Conference in Adelaide, the AMLR NRM Board’s Coast, Estuary and Marine Advisory Committee endorsed support for a workshop or forum to address collaborative national approaches to coastal vehicle management issues with the aim to allow discussion and networking to progress a coordinated national approach to the issue. A discussion paper and workshop was held at Coast to Coast 2012 Conference.

The AMLRNRM Board’s (now defunct) Coast, Estuary and Marine Advisory Committee should be commended for championing national investigations into collaborative approaches to coastal vehicle management issues however need further support at the state level to effectively implement social change.

In many areas of conservation value in the study area, activities have been undertaken to restrict ORV access to defined routes/ exclude them from sensitive areas. These include fencing, bollards, signage and vegetation. To date these measures have had varying success, however it is anticipated that there will be an increase in visitation to shorebird areas by recreational ORV users as the necessity to travel further in search of isolation increases.

ORV management on beaches are a complex, multi-jurisdictional problem. To address this, there are several examples of “Vehicle Action Groups” (or similar collaborative partnerships) that have been formed to work towards shared goals of ecological protection, human safety and increasing education of ORV users.

Figure 32. Dirt bike riders regularly damage fencing to access saltmarsh and claypan areas, Pt Prime. Photo: Chris Purnell

iv) Other sources

Other recreational activities in the Gulf, such as land-yachting jet skis, flyboarding and para-surfing, can all discourage shorebird feeding and roosting. These activities have caused multiple disturbances at many sites, including Port Parham, Port Gawler, Light Beach and throughout the Samphire Coast, especially Thompson Beach and the saltpan at Third Creek.

The evidence of increased disturbance can be more tangibly measured in resident beach-nesting shorebirds than on migratory shorebirds. Preventable sources of breeding failure or mortality arise from people, vehicles or dogs on the beach; all of these can disturb birds to the point that they are unable to incubate eggs or brood their chicks to maintain a suitable temperature or to ensure they are fed. Populations of Hooded Plovers (listed as Vulnerable under the *National Parks and Wildlife Act* [1972]) breed on the beaches of the southern Fleurieu Peninsula, from Sellicks Beach to Port Willunga. They and the more widespread Red-capped Plover and Masked Lapwing are threatened by human-induced breeding failure or mortality, and other pressures such as predation by foxes (Dowling & Weston 1999; Weston 2000).

Some form of disturbance occurs in most shorebird areas, but their effects are not fully understood, as birds may be able to find refuge in nearby habitat. Observations suggest that disturbance often occurs in many areas throughout Gulf St Vincent, forcing shorebirds to continually move, thus compounding the effect of each disturbance. This is likely to increase as coastal development expands. It is, therefore, important to set buffers to disturbance around these important shorebird areas now, before more areas become adversely affected.

In 2009, the Australian Government's House Standing Committee on Climate Change, Water, Environment and the Arts presented its report into climate change and environmental impacts on coastal communities. Committee Recommendation 32 states that the Australian Government must work through the Natural Resource Management Ministerial Council and in consultation with Birds Australia (now BirdLife Australia) and other stakeholders to implement a National Shorebirds Protection Strategy. The strategy should focus on tightening restrictions on beach driving and access to bird breeding habitat, preserving habitat, identifying suitable buffer zones for migration of coastal bird habitat, managing pest animals and increased public education.

In July 2011, the Natural Resources Committee of the Parliament of South Australia undertook a fact-finding visit in the northern area of the Natural Resources, Adelaide and Mount Lofty Ranges Region. The Committee noted the significance of the remnant samphire habitats and the importance of the area for migratory shorebirds. They also noted the threats to migratory shorebirds and habitat from "*encroaching housing and industry, uncontrolled access by off-road vehicles, vandalism*" and sea level rise. Recognising the work already being undertaken by the NRM Board and local councils, the Committee recommended that the Gawler Conservation Park be expanded to include more of the samphire flats and that a campaign be developed to promote the importance of this critical coastal habitat (Parliament of South Australia 2011).

Actions to increase awareness are part of the Samphire Coast Icon Project, (however Australian Government funding for this project ceases in June 2017). Additionally, the Department of Environment, Water and Natural Resources, with financial support from non-government organisations, has acquired the southern portion of Buckland Park Lake, with the intention of incorporating this portion of land (along with the northern portion of the lake) into the Gawler River Conservation Park.

BIRDLIFE AUSTRALIA RECOMMENDATIONS

22. Seek to continue important integrated management works undertaken as part of the *Samphire Coast Icon Project.*

23. Recommend legislative approaches (such as the Western Australian Control of Vehicles [Off Road Areas] Act and the Victorian Land Conservation [Vehicle Control] Act 1972) that can provide effective mechanisms for local government to manage off road vehicle issues Legislative approaches need to be combined with planning and community awareness support for local jurisdictions.

24. Set initial buffer distances around identified habitats at 250 metres to limit the impacts of disturbance, and use active monitoring to explore how to adjust those buffers with the understanding that buffers less than 250 metres may be sufficient in some areas, or for some forms of potential disturbance.

25. Secure operation boundaries at Dry Creek Saltfields to reduce unauthorised access by recreational fisherman, hunters and off-road vehicle users.

26. Encourage dog walkers to keep their dogs leashed when in shorebird areas.

27. Introduce and enforce restrictions on off-lead dogs in priority shorebird areas during migration/breeding season (September–March).

28. Continue to address systemic compliance issues surrounding use of off-road vehicles and shorebird disturbance through public engagement (signs, brochures, meetings, media).

29. Investigate integrated social change initiatives targeting off-road vehicle users.

30. Provide community engagement and/or environmental mentors for off-road enthusiasts.

31. Conduct a census on visitation rates at Thompson Beach to deduce the interaction/disturbance rates caused by recreational crabbers.

32. Devise and implement temporal/spatial bans on crabbing at high priority shorebird areas (i.e. limit crabbing activities to within 6 hours either side of the morning high tide).

33. Enforce catch and size limits on recreational crabbing.

34. Provide safe, cost effective and easily accessible alternatives for off-road enthusiasts in areas not likely to impact upon conservation values.

c) Domestic and introduced mammals

In natural ecosystems, there is a co-evolution between predator and prey species, with prey species evolving evasive or defensive behaviour in concert with evolving prey-capturing behaviour by predators. However, when exotic predators are introduced into an ecosystem, they often thrive in these environments, reaching high population densities. Because native species of prey have not evolved to cope with the strategies of these predators, their impacts can be severe (Maguire 2008).

Introduced animals pose a readily identifiable threat to shorebirds in Gulf St Vincent. Rats, dogs, foxes and cats have all been observed in shorebird habitat during the study period, and are likely to pose a threat to resident shorebirds in the Gulf. These exotic predators give rise to increased disturbance and surveillance behaviour among all shorebirds, and this is ultimately manifested in reduced feeding rates, increased energy expenditure and reduced breeding success.

i) Foxes

There is considerable variation in the impact of foxes on shorebirds. It is thought that even though urban development can encourage population densities of foxes that are three or more times greater than in rural areas (Coman *et al*. 1991; Marks & Short 1996), it is in relatively pristine areas that foxes become the dominant local threat to shorebirds, particularly beach-nesting birds. On the Victorian coast, for example, rates of nest failure of Hooded Plovers of 17–27 per cent were attributed to predation by foxes (Weston 2003; G. Maguire, unpublished data). Elsewhere, in Western Australia, the contents of one fox's stomach contained the remains of 38 Red-capped Plovers (Geering *et al*. 2007).

Mapping of active fox dens adjacent to high-value shorebird habitats between Port Gawler to Port Parham was undertaken in 2010–11 through the Adelaide and Mount Lofty Ranges Natural Resources Management Board and identified six fox dens (Greening Australia 2011). Ongoing control is planned throughout the region.

Eradication across large urban and agricultural landscapes can be a difficult ongoing process, as new individuals regularly move into newly vacated territories. Additionally the risk to domestic dogs and perceived risk of litigation that may occur if poisoning occurs, can dissuade agencies and land managers from control. However, quick gains can be made in isolated areas such as islands. Section Bank/Bird Island has been identified as a significant area for several shorebird species and also supports regular breeding populations of four resident shorebirds as well as several species of waterbirds and terns. Given the reduced opportunities for colonisation by terrestrial predators — mainly through low-tide land bridges — Section Bank/Bird Island could easily be secured as a fox-free refuge for these ground-nesting species with minimal management input.

A memorandum of Understanding has been undertaken with the ministers for Environment and Transport and the Port Authority to better enable conservation management, including pest management control on the island.

Figure 33. A fox at Barker Inlet Wetlands. Photo Chris Purnell.

ii) Dogs

Domestic dogs are not only the greatest source of disturbance to shorebirds (Figure 34) but they have also been recorded preying on both eggs and birds (Buick & Paton 1989). However, even when leashed, dogs are recognised as a greater cause of major disturbance to shorebirds than people. This is due to the unpredictable behaviour and non-linear paths that dogs walk, as well as their obvious similarities to traditional shorebird predators. In a study of the Western Snowy Plover in North America, people with dogs were found to cause flushing of birds 100 per cent of the time once they were within 50 metres, and 52 per cent of the time when they were within 100 metres (Page *et al*. 1977). NR AMLR and BirdLife Australia have been providing advice to councils on local dog by law reform as these regulations are reviewed, particularly with reagrds to beach-nesting bird conservation.

Figure 34. Unleashed dogs disturb feeding shorebirds and gulls at St Kilda. Photo: Peri Coleman

iii) Rats

The impact of exotic rats on seabirds and other ground nesting birds and island biodiversity, has been widely documented (Jones et al 2008). Black Rats (Rattus rattus) are known to have caused extinctions on islands overseas and exotic rats have caused or contributed to the extinction of a number of Australian native bird species by preying on their eggs and young chicks. There is considerable concern over the impact of exotic rats on Australian native species through predation. They may also have an indirect impact on the abundance of other native predators, through competition (TSSC 2006).

Black Rats feed on refuse around seabird nesting colonies, and may also prey on the eggs and chicks of ground nesting birds, and so are likely to be affecting the breeding of ground nesting birds on Bird Island. On Bird Island, rat populations undergo an annual flux related to the timing of bird breeding on the Island – with peak numbers following the principal bird breeding time during winter, and with a population crash in the summer months (Milne and Telfer, 2014).

In 2006, the Australian Government listed exotic rodents on islands as a key threatening process under the Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act) and developed a threat abatement plan for rats and mice on islands less than 100 000 ha in area.

An analysis of penguin breeding success on Granite Island since 1990 (Colombelli-Négrel and Kleindorfer,2014), showed that rat predation particularly influenced the number of fledglings produced per pair, confirming the results found by Bool et al. (2007) that predation pressure mainly occurred on chicks but not on eggs. In addition, the recent study showed that predation rates at penguin burrows significantly decreased following extensive rat baiting.

Rat control is being undertaken by NR AMLR on Granite Island off the Fleurieu Peninsula and more recently Bird Island off of Outer Harbor. Current Bird Island rat control is being monitored, as well as Silver Gull numbers, as one risk identified is that it may result in increased silver gull numbers which themselves have potential to predate other native seabird and shorebird eggs and chicks.

BIRDLIFE AUSTRALIA RECOMMENDATIONS

35. Build upon an integrated, adaptive management fox control program throughout the Metropolitan, Wakefield, Mallala and Light Regional Councils.

36. Conduct an audit of fox den mapping in the Samphire Coast including major likely source populations on private or leased lands (agricultural properties, the Dry Creek saltfields, Buckland Park, SA Water properties, Globe Derby equine farcicalities.)

37. Build feral mammal identification and control toolkits for landholders.

38. Initiate regular fox control measures to secure Section Bank/Bird Island as a shorebird refuge. Prohibit dogs from Section Banks during the migration/breeding season (September–March). Explore possibilities of Canid Pest Ejectors (CPE) during these periods.

39. Remove refuse/vegetation which is likely to provide fox harbour.

40. Provide training to residents and visiting volunteers on how to monitor fox behaviour and contribute to control.

41. Introduce and enforce restrictions on off-lead dogs in priority shorebird areas during migration/breeding season (September–March).

42. Prohibit dogs from Section Banks during the migration/breeding season (September–March).

43. Continue to monitor rat numbers on Bird Island and undertake control when necessary.

d) Invasive plants

Coastal sand dunes and surrounding habitat are under threat from environmental weeds. This threat is recognised by local councils and control measures are in place. Rice or Cord Grass *Spartina*, Marram Grass *Ammophila arenaria*, Pyp Grass *Ehrharta villosa*, Sea Spurge *Euphorbia paralias*, African Boxthorn *Lycium ferrocissimum* and Tree Mallow *Lavatera arborea* are hardy, opportunistic colonisers which threaten to choke shorebird habitat.

Spartina is a potential threat to the coastal wetlands of Gulf St Vincent. It is considered a threat to waders due to its impacts on mudflat habitats. A sterile variety of *Spartina* was planted at Port Gawler in the 1930s by the Waite Institute. It infested the edge of the mangroves, though it covered less than a hectare in 1997. The species appears to have been successfully eradicated at Port Gawler in 2006 through herbicide and manual removal (D. Fotheringham, pers. comm.)

Marram Grass was introduced from Europe in the 19th century to stabilise mobile sand dunes, and it has successfully colonised areas of open substrate throughout Gulf St Vincent, where it has displaced indigenous vegetation. Chosen for its strong vertical growth and capacity to hold a large volume of sand, Marram Grass has changed the morphology of foredune systems from low, terraced dunes to higher dunes with steeper sides. Lower-terraced dunes are preferred by resident shorebirds such as Hooded Plovers and Red-capped Plovers, as are sparse native grasses which provide incubating birds with uninterrupted surveillance (Park 1994). Marram Grass is most common on beaches south of Outer Harbour, where it dominates, and has probably contributed to the decline of shorebirds in that area. Ongoing vigilance and awareness on recognising this plant is necessary.

Sea Spurge, a native of the Mediterranean coasts, occurs on free-draining sandy beaches, around estuaries, on dunes and in other associated coastal habitats (Wilcock 1997). It is widespread throughout the Gulf, especially north of Middle Beach. Infestation by this plant may impact on beach-nesting birds such as terns, Hooded Plovers and Red-capped Plovers (Park 1994; Rudman 2003) and may result in steep dunes that are susceptible to wave erosion. Sea Spurge has received much attention on the southern beaches, and the Seacliff to Brighton Beach Sand Dune Restoration Project has targeted the aggressive spread of the weed with a routine of spraying and hand weeding.

African Boxthorn and Tree Mallow are woody weeds that occur on ridges and dunes. Although more confined to urban beaches, they threaten to proliferate along coasts throughout Gulf St Vincent and have already had an impact on areas surrounding Middle Beach, Thompson Beach, Dry Creek Saltfields and Buckland Park Lake (Jensen 2004; Carpenter 2008). Infestations of these plants have blanketed bare sites favoured by nesting terns on Section Bank/Bird Island. They have also caused significant problems in coastal habitats elsewhere, including the loss of valuable shorebird areas on Mud Islands in Victoria and West and Encounter Islands in South Australia (Veitch & Clout 2002; Carpenter 2008), and internationally, the displacement of nesting puffins in the Northern Hemisphere (McKie 2005). When mature, these plants also provide preferred nesting habitat for Silver Gulls *Chroicocephalus novaehollandiae* (Carpenter 2008) and cover for introduced predators such as foxes and feral cats. It is important to note however that these plants have in fact added structure to the otherwise low lying vegetation which is now utilised by nesting Australian White Ibis *Threskiornis moluccus* and Eastern Great Egret *Ardea alba modesta*.

Significant pest plant control and restoration planning on 18 project sites has been undertaken as part of the Samphire Coast Icon Project, supported by the Australian Government in parallel with NRM investment. In 2014-15 these works resulted in 108 hectares of weed control across eight sites, including significant African Boxthorn control and restoration planning in the Light River, and 19 hectares of revegetation across 11 sites. Approximately 11,000 seedlings were planted and 27 kilograms of seed used for direct seeding.

44. Continue to control and remove invasive Sea Spurge from affected areas, and search for and eradicate any Sea Spurge, Tree Mallow, Marram Grass or African Boxthorn that appears in new areas. These invasive species spread rapidly and are difficult to control once established.

e) Encroachment into habitat by native vegetation

Some native plants also pose a threat to shorebird habitat in Gulf St Vincent, with incursion by mangroves occurring in many coastal areas. Mangrove and saltmarsh habitats are seral — that is, their boundaries do not stay the same over time, but change to reflect factors such as changes in sea level and supply of sediment. In some parts of the Gulf, areas vegetated with Grey Mangrove *Avicennia marina* are expanding at an unprecedented rate (Saintilan & Williams 1999; Harris 2011), and many young mangroves are sprouting among the saltmarsh plants (Figure 37). This is especially prevalent in Barker Inlet, where the saltmarsh is confined to an area between the mangroves and the seawalls, and has been gradually encroached upon since the 1940s so that now little remains.

There are many possible explanations for this trend of mangrove expansion. It has been suggested that the increased annual rainfall in the area since 1945 may have diluted salt levels within saltmarsh soils to the extent that mangrove colonisation was enhanced (Saintilan & Williams 1999). Increased nutrient levels and sedimentation from agriculture are also considered a possible cause of increased colonisation by mangroves (Hughes 2003; Straw & Saintilan 2006).

The expansion of mangroves can limit the availability of the open spaces that shorebirds use for roosting and feeding. Shorebirds prefer the security of open spaces with high visibility for the easy detection of approaching predators (Straw & Saintilan 2006). To illustrate shorebirds' preference for open areas, in a survey of 63 intertidal mudflats in nine estuaries in New South Wales, 90 per cent of ground-roosting sites used by shorebirds were more than 10 metres from 2-metre-tall trees and shrubs, and 83 per cent were at least 30 metres from 5-metre-tall trees (Lawler 1996).

The expansion of the Grey Mangrove in south-eastern Australia is viewed as unnatural. Pressure is currently being exerted by residential, coastal development, planning and management authorities to remove and destroy mangroves, partly to protect and reinstate other impacted habitats such as saltmarsh and mudflats. Estuary management planning is a useful tool that can integrate and balance policy directions for mangroves and other estuarine habitats in a strategic manner. Options for management intervention, such as the controlled removal of mangrove seedlings and saplings from key shorebird feeding grounds, as well as the restoration and creation of mudflats and saltmarsh, are being undertaken to conserve shorebird habitat in Hong Kong (Straw & Saintilan 2006). Mangroves should not be considered as 'bad' in isolation, but viewed as part of the mosaic of tidal habitats that are important for estuary function and health. In some areas of Gulf St Vincent, such as Dry Creek Saltfields, natural die-off of mangroves is exceeding their expansion. However overall within the Gulf, there appears to be a net increase in the extent of mangroves. Areas of greatest concern regarding impacts on shorebird habitat are:

- Section Banks
- Pt Gawler intertidal)

In 2010, AMLR NRM Board, in liaison with the Native Vegetation Council and PIRSA, removed planted mangroves in the Onkaparinga Estuary. With increased salinity in the estuary during drought conditions, it was considered that the spread of these plants threatened to change the character of the river and potentially cause a flood risk through constricting the river channel. Mangroves stands had not previously been recorded in the Estuary in recent history, and it is thought that the plantings were undertaken by canoeists who had transplanted seedlings from Barker Inlet.

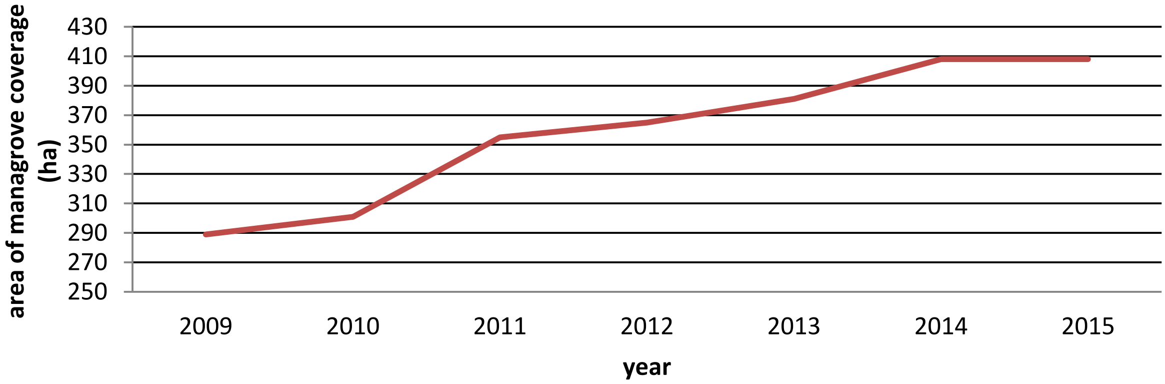


Figure 35. Change in mangrove extent measured from remote satellite imagery over a 5 year period at Port Gawler intertidal.

Figure 36. A Grey Mangrove propagule ready to root on open sand on Section Banks. Photo: Chris Purnell

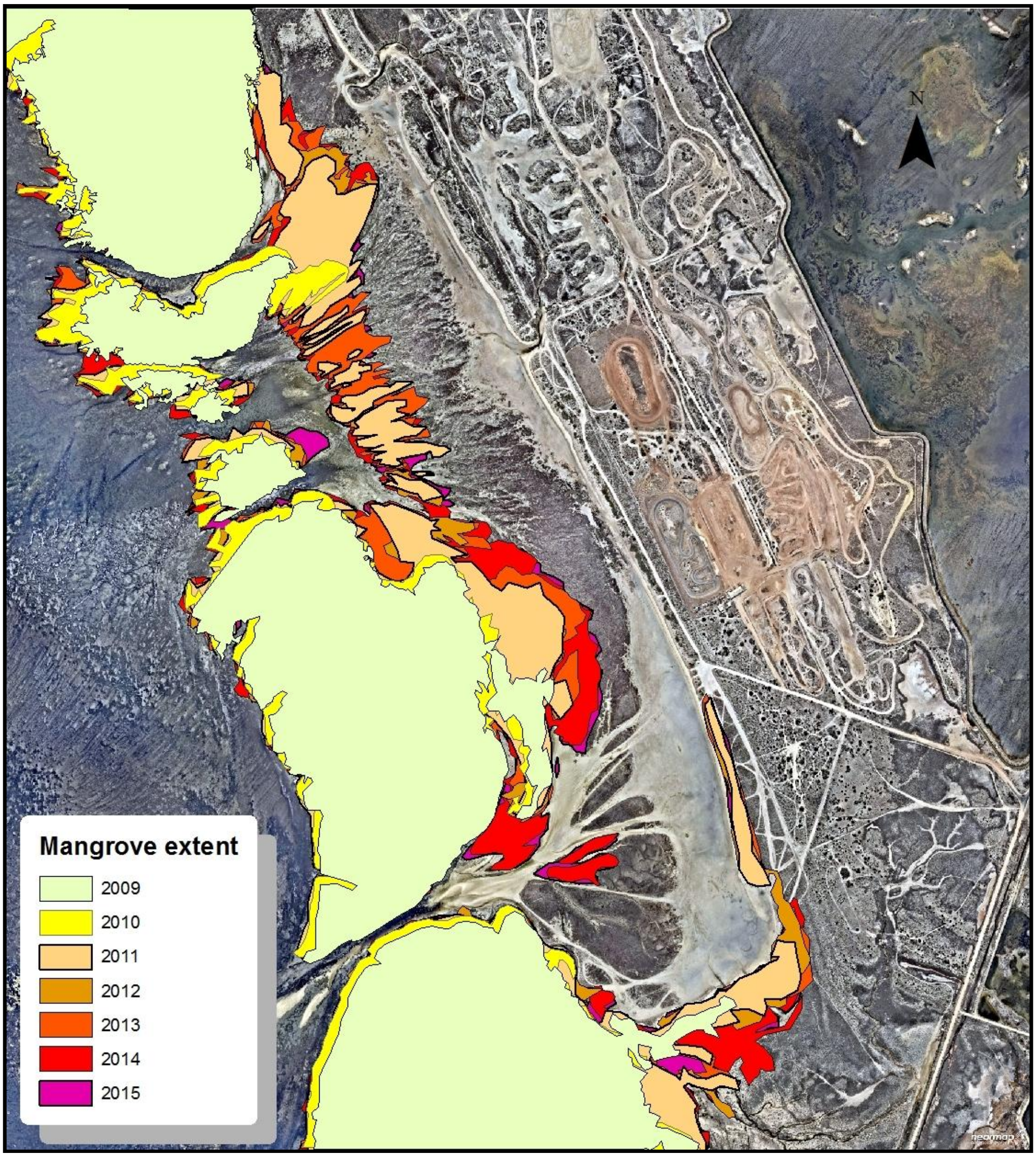


Figure 37. Satellite imagery reveals the extent of mangrove colonisation over a 5 year period in intertidal shorebird habitat at Port Gawler. (Image adapted from Nearmap imagery)

BIRDLIFE AUSTRALIA RECOMMENDATIONS

45. Investigate potential management options for Grey Mangroves to minimise encroachment onto significant shorebird habitat including

- Section Banks (Bird Island)
- Port Gawler intertidal
- Low saltmarsh, tidal creeks and claypan adjacent to ponds in Dry Creek saltfields

46. Mitigate the colonisation of mangroves that may occur when reinstating tidal flows to salt ponds through methods such as seedling weir traps.

f) Potential impacts of native birds

Locally nesting shorebirds are also under threat from expanding populations of opportunistic native birds. An increase in food resources, such as coastal rubbish tips and urban rubbish bins, may sustain artificially high populations of Little Ravens *Corvus mellori* and Silver Gulls.

i) Ravens

Ravens, which are also attracted by fruiting events of coastal shrubs, have been identified as the major predator of the eggs of beach-nesting birds and, to a lesser extent, their chicks (Weston & Morrow 2000; Maguire 2008). In New South Wales, Victoria and Tasmania, ravens have been identified as predators of Hooded Plover and oystercatcher chicks, accounting for up to 11 per cent of nest failures (Hanisch 1998; Weston 2000; Weston & Morrow 2000; Berry 2001; Keating & Jarman 2003; Maguire 2008).

ii) Gulls

Populations of Silver Gulls have increased substantially throughout Australia (Blakers *et al*. 1984; Higgins & Davies 1996; BirdLife Australia Atlas of Australian Birds, unpubl. data), and this has been mirrored in the Gulf over the last 50 years, reflecting the increased availability of food at rubbish tips (Carpenter 2008). Generally, beach-nesting birds are effective at defending their eggs and chicks against Silver Gulls (Weston 2000). However, Silver Gulls are able to approach nests more closely when the attending adults are disturbed and have moved away from the nest. This may suggest that gull predation is more likely to be a factor in highly disturbed areas (Weston 2000; Maguire 2008). Silver Gulls are suspected to have some impact on nesting Red-capped Plovers, Fairy Terns and Crested Terns at several sites in Gulf St Vincent. This can manifest in

- direct predation of eggs or chick,
- disturbance of brooding parents and/or precocial young leading to a decreased likelihood of survival to fledging age or
- competition for nesting sites

The negative impact that Silver Gulls have on nesting shorebirds has, in the past, prompted active gull control in Gulf St Vincent (Baxter 2003). Changes to the management of Wingfield Rubbish Tip since 2005 have reduced the amount of food available to gulls, which has resulted in a reduction of their numbers and restricted their breeding opportunities, but, nevertheless, they still occur in enormous numbers around the Gulf, and the Integrated Waste Services northern landfill site at Dublin provides an attraction near key shorebird areas.

A breeding colony has successfully established in the Port Adelaide/Middle Beach area. In Section Banks 2013/14 the colony had two discrete breeding areas on Section Banks (c >6,000) at the eastern and western extremities of the sand bank. In the 2014/15 season this colony, perhaps displaced by continued works on Section Banks, colonised low saltmarsh covered islands in Section 4 of the Dry Creek Saltfields 2014/15 (c >8,000).

Population control of Silver Gulls has been successful in several parts of Australia however due to the adaptability and mobility of colonies requires a coordinated program consistent program. Given the Gulf St Vincent colonies often exist in habitats which also support non-pest species physical methods of exclusion including scaring, netting and habitat modification will not be appropriate as they are likely to preclude use by other non-target species. Species specific methods of population control include:

- Removal of eggs (every 2 weeks during breeding). This can be labour intensive given birds have several attempts in a season.
- human disturbance at established colonies (Smith and Carlile 1993)

- Egg-pricking or "oiling" (canola oil is 99 to 100% effective in preventing hatching (Martin et al 2006). This is preferable as it induces adults to sit on infertile eggs rather than attempting to lay another clutch (Blockpoel and Hamilton 1989).
- Selective professional culling of adults by shooting or application of Alpha-choralose to food likely to be scavenged by Gulls like bread.

BIRDLIFE AUSTRALIA RECOMMENDATIONS

47. Investigate methods to manage Silver Gull populations

48. Discourage feeding (intentional or incidental) of Silver Gulls by the public by providing interpretive signage encouraging responsible disposal of waste.

49. Work with councils to ensure sites of waste disposal and collection are appropriately covered.

g) Human-induced mortality or breeding failure

The resident shorebirds that occur on several sandy beaches and claypans around Gulf St Vincent are under threat of accidental human-induced mortality or breeding failure. In these areas the threat is primarily due to shorebirds' well-camouflaged eggs or chicks that are accidentally stepped on or run over by vehicles. Eggs of Australian Pied and Sooty Oystercatchers and Red-capped Plovers are well camouflaged and are laid directly onto the sand, so they are especially susceptible to accidental crushing. Chicks are also easy to overlook and trample.

Figure 38. Red-capped Plovers forage, roost and nest on tracks in Dry Creek Saltfields. The eggs and chicks are vulnerable to being crushed by vehicles. Photo: Chris Purnell

Vehicles have also been identified as a risk for breeding Red-capped Plovers at the Dry Creek and Price Saltfields. Access tracks running between the evaporation ponds in the Dry Creek Saltfields are favoured by Red-capped Plovers as nesting sites, and during vehicle-based monitoring surveys throughout the study period, only vigilant driving prevented many chicks from being run over. Due to the narrow width of these roads, chicks have few escape routes, and some were seen trying to outrun cars. Cheetham Salt's staff were been trained to be aware of wildlife on the tracks, and visiting birdwatchers have also been alerted to the threat, however it is unclear whether contractors currently accessing the site are aware of the issue. With an increase in contractors and stakeholders accessing the Dry Creek site during the planning and subsequent decommissioning period there is an equally increased potential for detrimental impacts on breeding shorebirds.

Fencing of priority conservation areas, such as the claypans from Light Beach to Port Parham has had varying success in precluding off-road vehicles.

Figure 39. A Red-capped Plover nest at Thompson Beach, less than 20cm from dirt bike tracks. Photo: Aleisa Lamanna.

BIRDLIFE AUSTRALIA RECOMMENDATIONS

50. Surveys of breeding shorebirds should be encouraged to identify and protect easily impacted breeding areas. BirdLife Australia's Beach-nesting Birds project are working closely with the Samphire Coast Icon Project to improve our knowledge of these populations and engage local communities on how to monitor and conserve them.

51. Include a shorebird awareness component in the Dry Creek site induction process and ensure future purposes limit vehicle use in remaining roosting and breeding areas.

52. Provide training for contractors working within saltfields on minimising shorebird disturbance and avoiding mortality.

Figure 40. A Banded Stilt found under disused power lines adjacent to Pond XB3 30/1/2016.

h) Bird strikes and infrastructure collision risks

Birds are vulnerable to collisions with man-made fixed structures such as buildings transmission towers electricity lines and wind turbines (Erickson et al . 2001 , Manville 2005, Rioux et al 2013). Vulnerability to collisions with transmission lines varies across bird groups Bevanger (1998) found that mortality by shorebirds (40%) was the most frequently reported in the US followed by waterfowl (24%). Shorebirds are particularly susceptible to collision with wires for a multitude of possibilities:

- Their tendency to move in flocks
- The altitude of non-migratory flight
- The otherwise low structural nature of shorebird habitat.
- Dawn/dusk and nocturnal movement of shorebirds in accordance to tide conditions

Electrical lines not only cause direct mortality of birds but they can also cripple indivuals leaving them susceptible to predation or reducing their fitness to a point that they either starve or reduce their potential fecundity.

Landscape features will affect the flight path of birds, potentially funnelling them towards powerlines (Bevanger1990, Martin and Shaw 2010, Rioux 2013) which makes line orientation an important feature in planning (APLIC 2012).

In Gulf St Vincent the majority of likely line strike related fatalities and injuries are recorded at the Price saltfields (Pedlar and Treloar pers comms) and Dry Creek Saltfields. These strikes likely occur with lines which run parallel to the coast and therefore create obstacles to birds moving to and from the intertidal zone from the salinas. Banded and Black-winged Stilt make up the majority of the apparent strike fatalities and injuries however Red-necked Stint and Sharp-tailed Sandpiper have also been recorded.

Windfarm developments have previously been proposed in the area adjacent to wetlands. Such proposals should take into consideration the vicinity of nearby shorebird and waterbird roosts and populations to mitigate bird strike. Not only is there a risk to the birds, but collision with larger waterfowl such as swans and pelicans which use these areas could significantly damage infrastructure.

BIRDLIFE AUSTRALIA RECOMMENDATIONS

53. Remove redundant electrical lines, in coastal areas (particularly in Dry Creek and Price Saltfields)

54. Incorporate likely shorebird flight paths into planning for any new infrastructure to exceed 2m in high for coastal areas.

i) Pollution

The main sources of pollution in Gulf St Vincent include sewage effluent discharge (organic matter, nutrients, pathogens), storm-water runoff (heavy metals, oils, litter), agricultural runoff (fertilisers, pesticides, suspended solids) and industrial waste (Edyvane 1999). Some contaminants, particularly heavy metals, can persist and become increasingly concentrated in higher trophic level organisms, including birds.

i) Nutrient pollution

Sewage outfall into marine habitats has been linked to various effects on native flora and fauna. Of particular note, sediments near nutrient-rich sewage discharge points are believed to support high densities of invertebrates, and the species composition of these sites differs from those at sites further away (Poore & Kudenov 1978; Davies & Brown 1995; Rogers *et al*. 2007). As a consequence, this enhanced production may support large numbers of shorebirds and it has been noted that improvements in sewage treatment and disposal may lead to a decline in shorebird numbers (van Impe 1985; Raffaelli & Hawkins 1999).

Recent studies which took into account only shorebird prey have had varying results, with the number of certain species such as polychaetes (common prey of species such as godwits and knots) showing a clear gradient extending out from the sewage outfall, whereas other species show the reverse or no gradients at all (Rogers *et al*. 2007; Alves *et al*. 2011).

While moderate organic enrichment might be seen as having a beneficial effect on shorebird habitat, nutrient enrichment by sewage can also stimulate blooms of opportunistic benthic macroalgae, especially the green *Enteromorpha*, *Cladophora* and *Ulva* (Knox 1986; Rafaelli and Hawkins 1999; Mackenzie 2000). Nutrient enrichment or coastal eutrophication as elsewhere in Australia and the world, has been recognised as the highest priority marine issue in Gulf St Vincent, as it is elsewhere (DELM 1993; Edyvane 1999). The most obvious symptom of eutrophication is the loss and degradation of seagrass (Larkum *et al*. 1989). Such losses are evident at the site of the Bolivar Waste Water Treatment Plant Outlet, where 470 tonnes of nitrogen, 27 tonnes of ammonia and 190 tonnes of phosphorus where discharged into the Gulf in 2007 alone (EPA 2009). These levels represent reductions of 68, 72 and 9 per cent, respectively, in the levels of nitrogen, ammonia and phosphorus discharged since 1999, but still fall well short of the EPA's projected reductions to 318 tonnes by 2010 (EPA 2005).

Nutrients and turbidity caused by the discharge from the Outlet has been linked to a die-off of seagrass communities (most notably *Amphibolis* and *Posidonia*) in a 19-kilometre stretch from St Kilda to Middle Beach (Kinhill *et al*. 1995; Edyvane 1999; Coleman & Cook 2000; Fox *et al*. 2007; P. Coleman, pers. comm.).

The loss of seagrass equates to a loss of local biodiversity — a 40-fold difference exists between biodiversity in seagrass and bare-sand communities (Fox *et al*. 2007). The absence of seagrass meadows and an increase in nutrients has seen this area of intertidal mudflats now colonised by mats of Sea Lettuce *Ulva lactuca*. Sea Lettuce is well-known nitrogen scavenger, and if dense algal mats are able to become established they can have catastrophic effects on the underlying invertebrate assemblages through deoxygenation of sediment (Raffaelli & Hawkins 1999; Mackenzie 2000). Such a decline in benthic prey species would explain a surprising absence shorebirds feeding in the intertidal zone between Middle Beach and St Kilda. The greatest rate of loss of seagrass occurred in the early 1970s, about eight years after the maximum rate of population growth in the metropolitan region was recorded (Kinhill *et al*. 1995).

Wastewater discharges from the now closed Penrice soda factory have been substantial, with historical annual nitrogen loads of up to a 1000 Tonnes. The cessation of this significant nitrogen source is likely to have positive benefits for adjacent marine environments in Barker Inlet and the northern coast.

Seagrass restoration trials off the metropolitan coast, being undertaken by SARDI with AMLR NRM Board support, now appear to be having some success, with seagrass regrowth infilling between some restoration plots. The overall reduction of nutrient inputs across the coast will hopefully improve the long term potential for restoration (Tanner 2016)

Seagrass restoration is a long term proposition. The work to date builds on collaborative approaches undertaken since 2002 across state agencies and NRM, with now limited resourcing. Continued investment in seagrass restoration methodologies would capitalise on progress made over the last few years.

A study into mudflat condition at four sites from Section Bank to Thompson Beach, funded by the Adelaide and Mount Lofty Ranges Natural Resources Management Board, found that although the intertidal zone in eastern parts of Gulf St Vincent has high species diversity, the overall biomass of invertebrate fauna is low. Contrary to assumptions based on the distribution of shorebird feeding sites, Thompson Beach was found to have markedly lower densities of invertebrates than Port Gawler[6] suggesting that the distribution of feeding and roosting sites for shorebirds may be driven more by abiotic features, such as habitat structure, than availability of prey (Dittman *et al*. 2012).

ii) Agricultural, industrial and storm-water pollution

Run-off from the area's water catchments or storm-water outfalls that are contaminated with phosphorous, nitrogen or other nutrients or chemicals could have a great impact on shorebird feeding areas, and they have already been linked to a die-off in seagrass in the Gulf (Close 2008). In addition, in some areas, increased agricultural run-off with high nitrogen content has been shown to lead to an initial increase in the diversity of invertebrates in the mudflats used by foraging shorebirds, but excess nitrogen leads to eutrophic conditions, which kills the food species (van de Kam *et al*. 2004). Initial seagrass condition monitoring commissioned by the Adelaide and Mount Lofty Ranges NMR Board shows seagrass on valuable shorebird habitat off the Light River delta to be in good condition, and they do not appear to be degraded due to discharges from the Light River.

The potential impacts of run-o ff from the proposed intake of toxic chemicals and heavy metals at Dublin's Integrated Waste Services northern landfill is a matter of contention between the local council, residents and Integrated Waste Services. The installation of a high-temperature waste-disposal system would drastically reduce any potential risk of waste held on site leaching into the Gulf and surrounding areas. Thermal pollution, industrial run-off, effluent disposal, ballast water, heavy metals and other toxicants have all been identified as factors that are likely to impact on the

[6] The study also reported significant patchiness in distributions of benthic fauna. Given survey effort was limited to two sampling periods on-going monitoring may yield a more complete picture of benthic fauna distributions.

Port River–Barker Inlet area, including valuable feeding areas such as Section Bank/Bird Island (Bryars 2003, 2013).

iii) Munitions

The coastline encompassed by the Port Wakefield Proof Range and Experimental Establishment is exposed to a different suite of potential threats due to its use as a munitions testing ground. Surveys conducted by Sinclair Knight Merz in 2007 uncovered many expended artillery shells on the tidal mudflats and many impact sites where the subsurface material had been exposed. The potential impact of this munitions testing on shorebirds remains unclear, with critical factors being firing regimes and the chemical composition of the munitions.

iv) Oil Spill

The South Australian Marine Spill Contingency Action Plan has designated Gulf St Vincent as a high-risk area (EPA 2006), with the threat of pollution in the shorebird areas focused around Port Adelaide. With the closure of the Port Stanvac refinery, the number of large oil tankers entering the Gulf has declined. However, fuel is now transported to facilities in Port Adelaide and this has increased the risk in that area. In 2004–05, 103 vessels unloaded over 2 million tonnes of petroleum product at Port Adelaide (CPAE 2012,Flinders Ports 2013).

Whilst there is no active oil production being undertaken in the Gulf, the area has been explored for petroleum and a number of lease areas exist. Petroleum exploration works in the mid-1960s resulted in bare seismic shot-holes scars in seagrass meadows off the metropolitan coast at Grange. However these scars are no longer visible due to the complete loss of seagrass where they occurred mostly between 1970 and 1977 (Fox 2006). In the 1990's exploration was marred by the collapse of the Mobile Offshore Drilling Unit, 'Maersk Victory' rig in Gulf St Vincent in 1996. Legs of the rig "punched through" a hard layer of sediment approximately 10 m below the seafloor leading to its collapse. The incident occurred before drilling activities had commenced. A Mines and Energy SA investigation
"found evidence that insufficient attention had been paid to evaluating the risks to the rig inherent in undertaking operations in an area where a jack-up rig had not previously been used" (MESA 1996). The footings of the rig were left on site of the main prawn fishing area called The Big Hole, hindering prawn trawling activities (SECITARC 2000).

Boat traffic in the upper sections of the Gulf is relatively low, but if an oil spill occurred, the effects could be catastrophic, having long-lasting effects on shorebird populations. Further, industrial development or increased capacity for more boats would increase the threat of a spill in these areas (Clemens *et al*. 2007a).

The Inter-Governmental Agreement on the National Plan to Combat Pollution of the Sea by Oil and Other Noxious Substances (2002) includes the process for recovering clean-up costs from the polluter. The State Government is committed to ensuring that all costs from oil spills, including environmental rehabilitation and monitoring, are met by those responsible. The South Australian *Environment Protection (Sea Dumping) Act* was passed by Parliament in 1984 to mirror Commonwealth legislation, but was never proclaimed. Therefore, the regulation of sea dumping in coastal waters currently rests with the Commonwealth. The Environment Protection Authority is currently reviewing the South Australian Act to align it — with subsequent modifications — to the Commonwealth's sea-dumping legislation. The State Government will negotiate with the Commonwealth to bring 'coastal waters' within the control of the South Australian Government by demonstrating compliance with the London Protocol (NCHD 2004).

BIRDLIFE AUSTRALIA RECOMMENDATIONS

55. Investigate measures to optimise use of wastewater and storm-water, with a particular emphasis on re-establishing seagrass beds in the literal zone adjacent to the Bolivar Waste Water Treatment Plant Outlet. Recommendations on rehabilitation of seagrass meadows are included in the Adelaide Coastal Waters Study (Fox et al. 2007) and are being undertaken by SARDi with AMLRNRMB support (Tanner 2016).

56. On-going mudflat condition monitoring and associated adaptive management.

57. Explore feasibility of “drip feeding” sewage outfall over several tidally reconnected salt ponds to reduce concentrations of nutrient at Bolivar outfall (see addendum to this report for more information.)

Section 1.03 Shorebird mapping

Shorebird habitat and count area mapping

The 2014/15 amendments to shorebird mapping provide the most spatially specific account of habitat in Gulf St Vincent to date. A combination of high resolution satellite imagery provided by Nearmap and Esri, NRM Board funded LiDAR layers, habitat/vegetation layers (Coleman et al 2009) and overlays of existing habitat mapping, supplemented 7 years of field studies. Shorebird habitats identified in the field were sufficiently recognisable from the satellite images and ground truthed using smart-phone GIS applications which aided in defining boundaries of polygons.

Boundaries of count areas and shorebird habitat were digitised on screen-displayed digital ortho-photos in ArcMap 10.3. The accuracy of these photos was confirmed by the comparison of GPS ground-control points with physical features. Shorebird feeding areas that had been determined in previous years were based mainly on a report which plotted polygons over shorebird areas (Close 2008). These were adjusted with reference to features visible on high-resolution digital ortho-photos, such as beds of seagrass, which provide a good indication of the boundaries of intertidal feeding areas. Due to the variable nature of some features in coastal environments, some of the polygons may not reflect the actual boundaries of shifting habitat features. A complete list of attributes, and further technical details of the GIS layers provided is available in the metadata which is separate to this report.

As discussed in 0; the Shorebird Monitoring project has expanded to include several areas in the Onkaparinga region, Onkaparinga River estuary

- Onkaparinga Oxboe (tidal creek and saltmarsh).
- Noarlunga Downs Wetlands (artificial freshwater wetland).
- Onkaparinga River Recreation Park Wetlands (natural ephemeral wetlands).
- Hart Rd Wetlands (stormwater detention wetland).
- Aldinga Scrub Reserve Wetlands (natural ephemeral wetland).
- Aldinga Washpool (natural coastal lagoon).

Given the majority of these sites are supratidal and condition is subject to available fresh water habitat has been defined simply as “feeding and roosting areas” in the 2014/15 mapping. These sites now appear in the Shorebird 2020 national count area network and will be monitored as part of the 2015/16 project.

Detailed accounts of all other mapped habitats are provided in the 2010 and 2011 *Shorebird Population Monitoring* reports (Purnell et al 2010, 2011).

Accuracy of mapping and attributes

Digital ortho-photos were found to be spatially accurate after comparisons with GPS field points. GPS readings fluctuated by only up to 10 metres in the field, but some features such as sandbars or the edge of mudflats may shift over time by over 100 metres. In a few remaining areas, the actual edge of the mapped shorebird habitat was uncertain, and boundaries were poorly defined. In these areas the discrepancy between our boundary and the boundary the birds used may be as off by as much as 50 metres and may depend on conditions of tide. Despite this variation in spatial accuracy of digitised static boundaries, all spatial boundaries are believed to include the core of the important habitat, and an estimate of spatial accuracy which generally applies only to the boundary edges is reported in the attribute table.

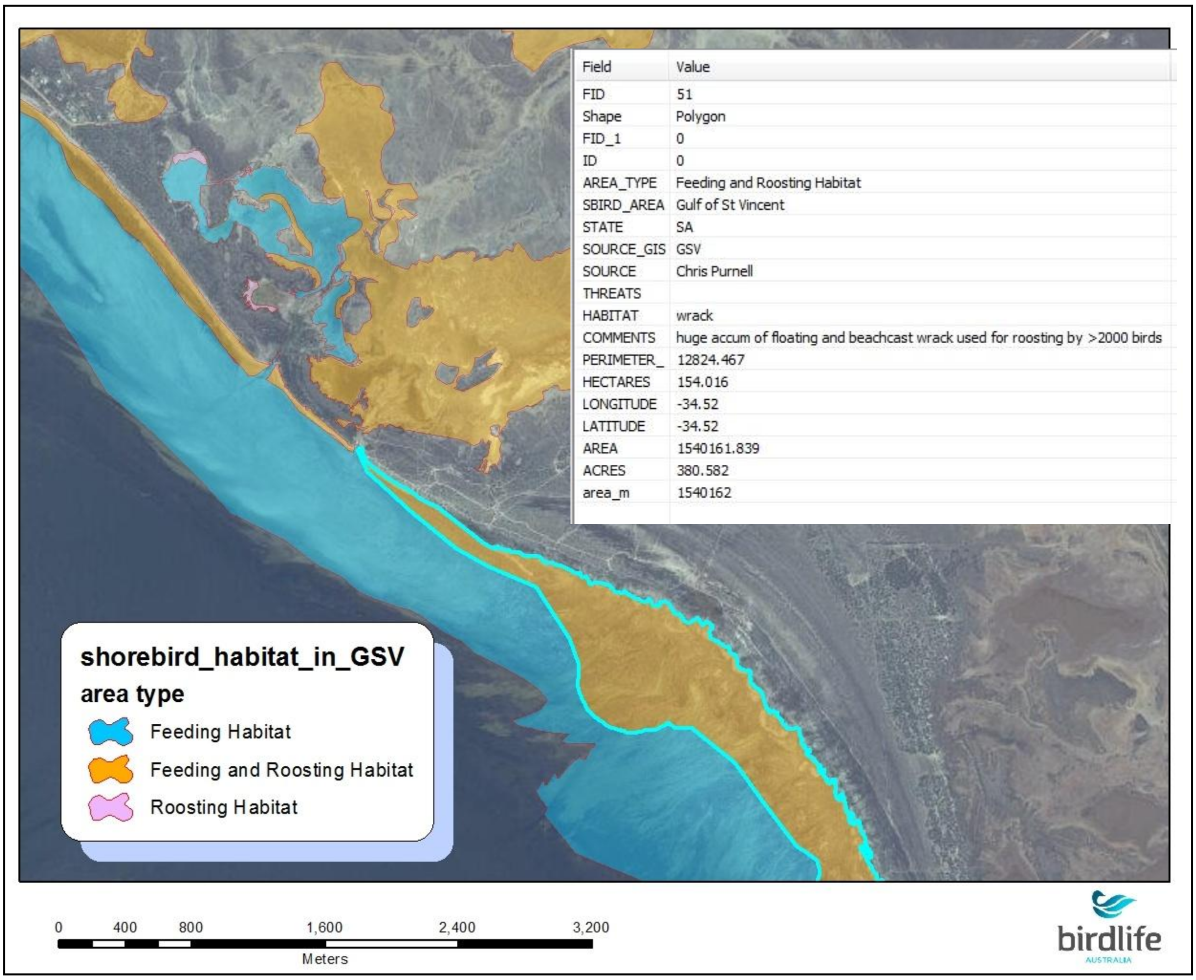


Figure 41. Clip of habitat mapping files and attributes provided in association with this report.

For planners and managers requiring greater spatial resolution, some generalisations may assist in future interpretation of important shorebird areas. In general, roosting areas near the mouths of tidal creeks and sand embankments such as Section Banks will continue to shift to wherever exposed sand remains at high tide. Further, they will be lost or diminished in importance as vegetation encroaches on roosting areas. Lastly, boundaries of feeding areas will change depending on where the channels shift to and as the distribution of benthic organisms shift.

Fine scale shorebird habitat mapping of Dry Creek saltfields has not been updated. Due to the variability in habitat being both created and lost as the site transitions from an active operation towards decommissioning it is impossible to quantify the amount of habitat available at any one time (See Section 1.02a).

2. 2014–15 SHOREBIRD COUNT

2.1 Count Methods

In 2010, power analysis was undertaken to establish how long it would take to deliver high levels of statistical confidence in shorebird declines in Gulf St Vincent. The results indicated that if the present level of monitoring were to continue for 20 years, a statistically significant change would be likely to be detected only if the population had declined by more than 70 per cent. To improve this, BirdLife Australia recommended two or three simultaneous counts to be conducted each season in Gulf St Vincent (Purnell *et al*. 2010). Following this recommendation, Birds South Australia organised three simultaneous counts for the summer of 2014–15 (Figure 44). If sustained, this level of monitoring would increase the sensitivity of our trend analysis to a level where declines of 47–64 per cent would be detected within a 20-year period.

Counts are conducted in line with the Shorebirds 2020 count methodology outlined at: **www.birdlife.org.au/projects/shorebirds-2020/counter-resources**. Counters are encouraged to contribute to simultaneous counts in which every *count area* within the *shorebird area* is covered within the smallest window of time. Counters are then asked to submit their result either by paper form (Appendix A) or through the new BirdLife Australia birdata portal (Figure 42).

The simultaneous counts during 2015–16 were organised for 27 November 2015, 29 January and 24 of February 2016 (Table 7 &8

). A winter count was also conducted on 22 July 2014. These dates were chosen to identify temporal changes in habitats used by shorebirds. Count coverage across the 19 count areas was incomplete across all dates, but each count covered all the most significant sites where possible. Notable exceptions were:

- Price Saltfields — Only covered in February counts due to difficulties arranging access.
- Clinton Conservation Park (3,500 shorebirds in previous counts) — Not covered due to logistical difficulties of access.
- Barker Inlet Wetlands were not covered due to access restrictions.

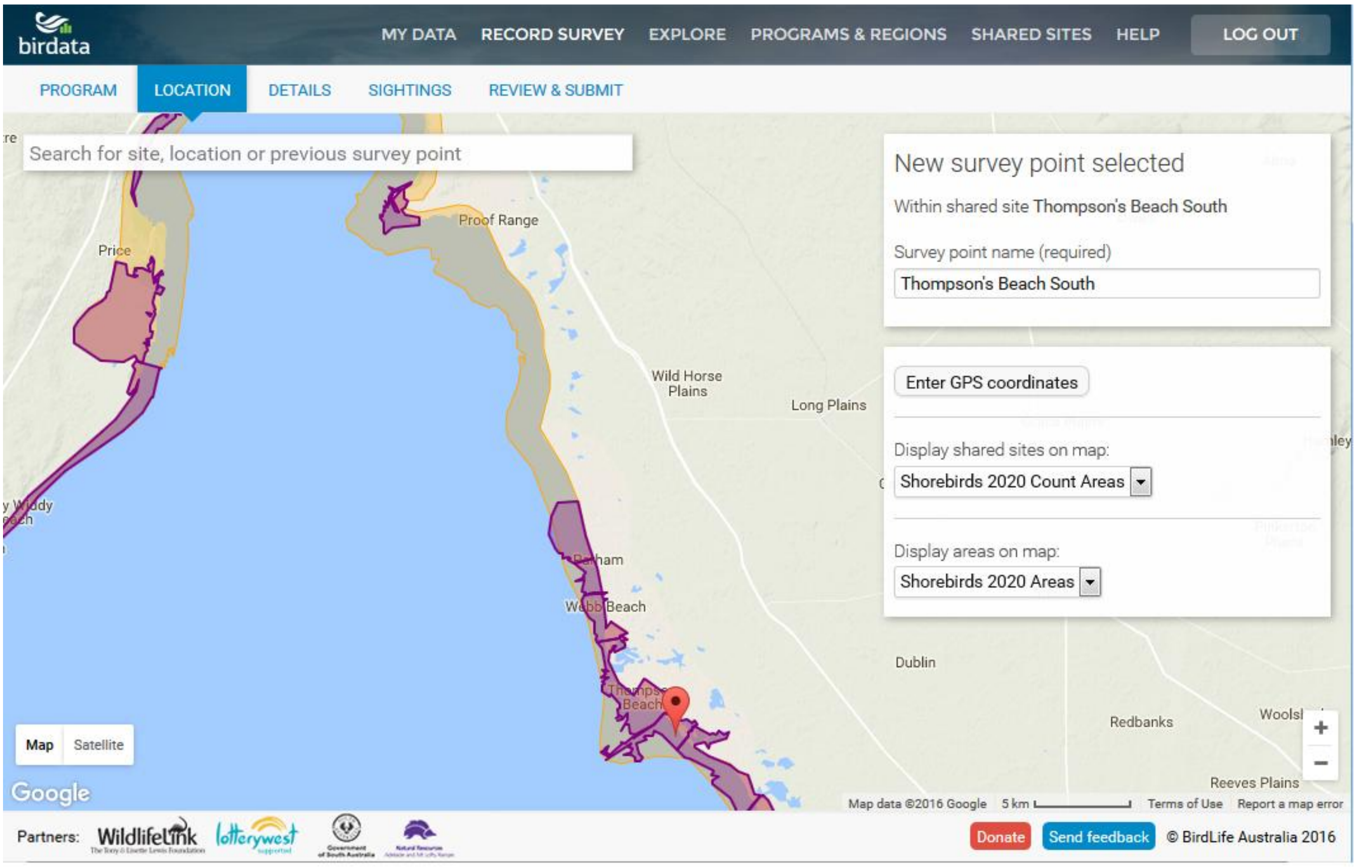
Shorebirds 2020 surveys of Dry Creek Saltfields were supplemented by those conducted by 3 counts conducted by EBS ecology on behalf of Ridley Corporation.

Unfortunately, variation and gaps in coverage will result in non-representative species abundance and totals for the region. Although areas like Clinton Conservation Park and Price Saltfields are not within the, Adelaide and Mount Lofty Ranges study area, they contribute to the same 'Shorebird Area' and are known to contribute significantly to habitat used by birds on the Samphire Coast. They are therefore critical monitoring sites when trying to identify large-scale trends. The current support provided by AMLR NRM Board does incorporate some capacity to monitor upper and western Gulf St Vincent. The need for cross regional action is recognised in a memorandum undertaken by the three NRM Boards across the Gulf for collaboration on managing the Gulf St Vincent.

i

A shorebird area is the boundary around the total area used by the same group of shorebirds during the peak of the non-breeding season (November–March). Regular bird movement may be observed between habitats within a shorebird area, but birds seldom move in or out of the shorebird area during the peak of the non-breeding season.

A count area is a fixed boundary which defines the area within which a count of all shorebirds is made during any repeated monitoring survey. These areas are predefined and are based on identified roost or feeding habitats. There may be one or many count areas within a shorebird area. Count areas tend to be marked by boundaries of readily identifiable geographic features, and include areas easily surveyed by one counter in less than 4 hours.



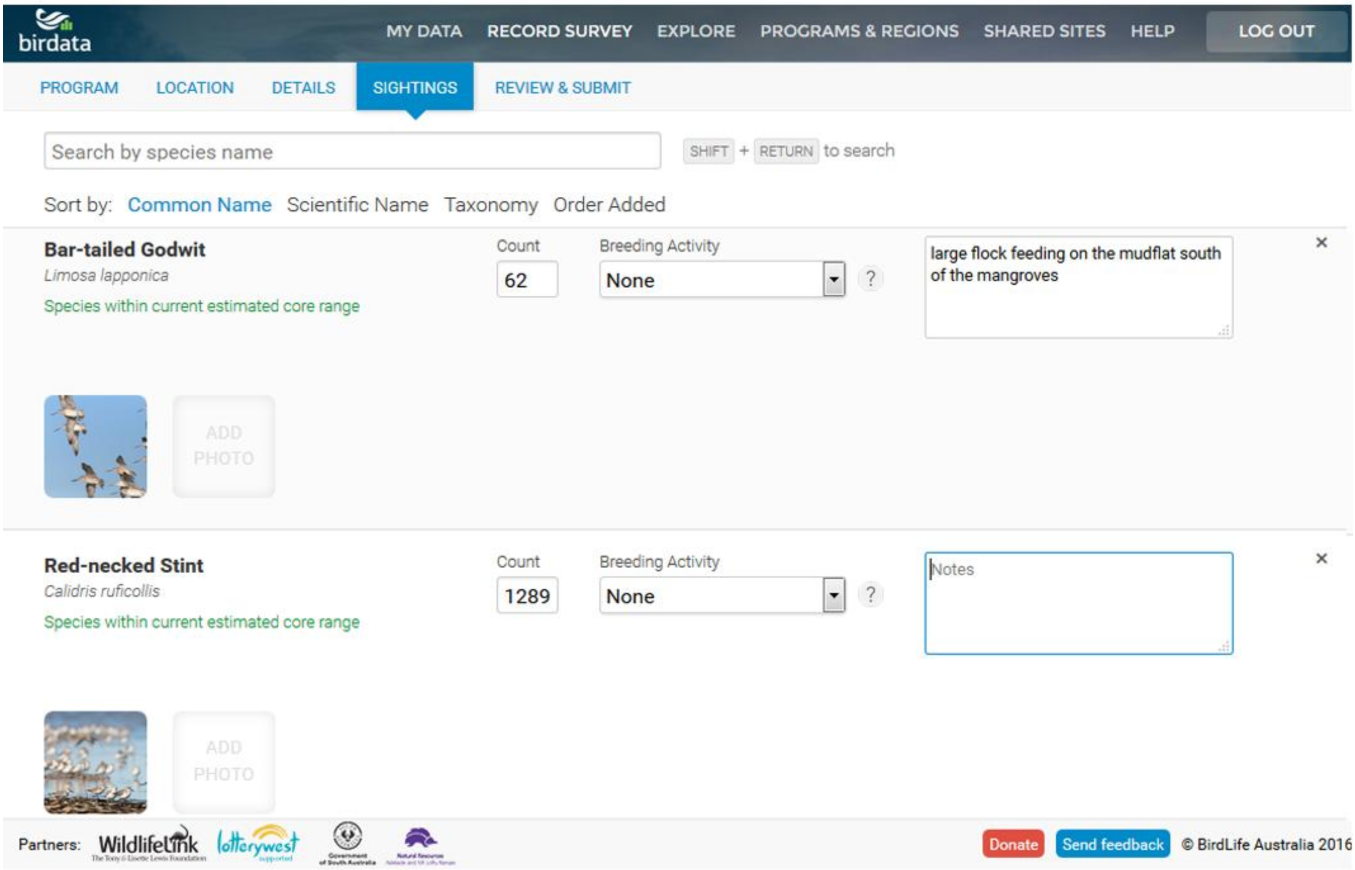


Figure 42. The new BirdLife Australia Birdata portal.

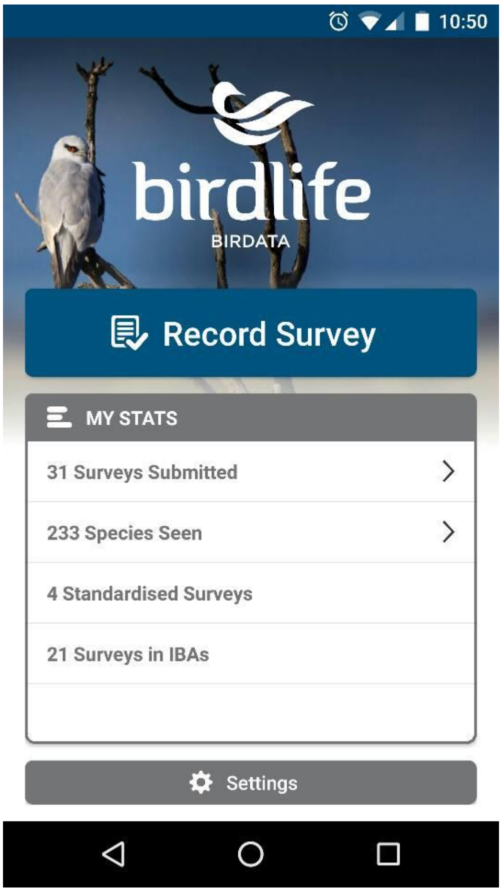


Figure 43. The new BirdLife Australia Birdata app

During the peak of the non-breeding season, shorebirds tend to remain within a defined region, moving between proximate feeding and roosting sites in accordance with variations in habitat conditions, such as tide height. Shorebirds often return to these same areas within and between seasons (Peters & Otis 2007). It has been suggested that there was little movement beyond the boundaries of the shorebird area as mapped in 2009, which extend north from Section Bank/Bird Island and around Gulf St Vincent to a point south of the Price Saltfields (Purnell *et al*. 2009). Shorebird banding and band reporting (described below) supports this theory. The site fidelity observed in most shorebirds suggests that any count conducted in Gulf St Vincent during the peak of the non-breeding season would encounter the same population of birds.

It is critical to conduct a coordinated survey within Gulf St Vincent so that multiple areas can be surveyed simultaneously. Birds are likely to be either missed or double-counted if counts are not conducted simultaneously throughout the Gulf. Further, these counts should be conducted during the peak of the non-breeding period, in the same month as previous summer counts. In terms of national population monitoring, counts conducted outside the November–February window risk a measurement error at a national scale, with entire populations of shorebirds potentially being counted twice or not counted at all (Clemens *et al*. 2007a).

The volunteers involved in the counts should be commended for their continued commitment and contribution. A total of 152 counts were submitted by 38 counters, equating to approximately 912 hours contributed by citizen scientists.

Figure 44. A Shorebirds 2020 volunteer surveying Thompson Beach. Photo: Chris Purnel

2.2 Historic data

As a recognised area of significance for shorebirds, the Gulf St Vincent population has been the subject of varying levels of biodiversity surveying since the late 70's. At the initiation of the ALMR NRM Board funded monitoring project, all available data from state and known private sources was incorporated into the Shorebirds 2020 database. This included a significant dataset from local shorebird expert David Close. Expert advice and literature had also been sourced from Cheetham Salt (Rix 1978, Cooper 1980) and Frank Day (Day 2004) however it was not until 2014 that Day's extensive dataset was incorporated into BirdLife databases. Given these surveys were not standardised (and are therefore not comparable to Shorebirds 2020 methodology or the results) they were incorporated into the BirdLife Atlas of Australian Birds as incidental records. The data include 1,458 surveys from the study area and 1,150 visits to the Dry Creek Saltfields. Although the data type is insufficient to establish population trends if has been useful in identifying species present and population minimums and (in some cases) maximums (Table 9). This data has been useful in the successful nomination for the Flyway Site Network. It will also be valuable if a nomination of the Gulf as a Ramsar wetlands of international importance is undertaken in the future.

2.3 Count Results

Species	1% EAA*	0.1%EAA*	Nov-08	Feb-09	Jan-10	Dec-10	Jan-11	Mar-11	Dec-11	Jan-12	Mar-12	Aug-12	Dec-12	Feb-13	Mar-13
Australian Painted Snipe**	12		0	0	0	0	0	0	0	0	0	0	0	0	0
Banded Lapwing**	270		0	90	0	0	65	0	0	0	0	0	0	49	27
Banded Stilt**	2060		12062	3252	2228	110	2	0	19843	11133	10771	0	24647	11425	12856
Bar-tailed Godwit	1460	146	419	575	337	163	70	324	0	8	53	14	152	824	13
Black-fronted Dotterel**	170		25	0	1	0	0	4	0	0	2	2	2	0	2
Black-tailed Godwit	1390	139	0	0	0	0	0	0	0	0	0	0	0	2	6
Black-winged Stilt**	2660		310	99	408	7	47	0	254	218	571	460	202	95	195
Common Greenshank	1000	100	154	703	367	241	36	19	104	169	170	2	173	59	80
Common Sandpiper	500	50	1	4	27	0	1	0	3	1	0	0	2	0	0
Curlew Sandpiper	1350	135	228	535	259	126	3	58	16	0	63	28	476	174	278
Double-banded Plover	500	50	0	4	0	0	0	0	0	0	0	0	0	0	0
Eastern Curlew	320	32	9	36	29	12	0	1	11	6	0	0	19	26	46
Great Knot	2900	290	930	203	6	800	52	750	0	40	0	22	44	70	4
Greater Sand Plover	790	79	2	8	10	8	0	2	0	0	15	0	0	3	0
Grey Plover	1040	125	164	291	122	46	47	25	19	42	73	13	68	152	36
Grey-tailed Tattler	440	44	1	4	0	1	0	9	5	0	4	0	0	5	5
Latham's Snipe	250	25	0	0	0	0	0	0	1	0	0	0	0	0	0
Lesser Sand Plover	1080	108	7	8	0	0	0	0	0	0	0	0	0	5	0
Long-toed Stint	250	25	0	0	1	0	0	0	0	0	0	0	0	0	0
Marsh Sandpiper	1000	100	20	7	3	6	3	0	6	1	3	0	1	7	29
Masked Lapwing**	2870		94	148	124	23	41	15	61	73	104	11	35	101	121
Pacific Golden Plover	1000	100	5	2	1	1	0	0	0	0	0	0	2	17	0
Pectoral Sandpiper	100	10	1	0	0	0	0	0	0	0	0	0	0	0	0
Pied Oystercatcher**	110	0	23	125	118	10	7	6	14	24	22	27	43	28	43
Red Knot	990	99	1150	1637	1103	200	4	1615	0	70	1097	110	1450	1980	87
Red-capped Plover**	950	0	608	4963	2026	80	119	19	1084	616	553	164	566	649	2194
Red-kneed Dotterel**	260	0	152	121	79	0	0	0	108	5	37	4	32	74	88
Red-necked Avocet**	1070	0	555	285	27	23	0	0	424	262	481	0	317	257	48
Red-necked Stint	3150	315	83,91	11791	6749	2324	2927	1372	3169	2820	3123	577	3830	2098	4619
Ruddy Turnstone	440	44	57	91	70	41	7	23	0	40	5	6	55	75	2
Ruff	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0
Sharp-tailed Sandpiper	1600	160	1205	3224	3120	74	5	0	752	218	79	0	1059	543	31
Sooty Oystercatcher**	40	0	0	160	61	0	0	3	0	1	0	26	13	5	0
Terek Sandpiper	500	50	0	2	1	1	0	0	0	0	0	0	0	0	0
Whimbrel	5500	550	6	26	4	3	0	0	0	0	0	0	1	0	1
Wood Sandpiper	100	10	2	2	8	0	0	9	0	0	1	0	0	0	0
total			**26580**	**28392**	**17289**	**4299**	**3436**	**4245**	**25869**	**15747**	**17223**	**1466**	**33189**	**18724**	**20811**

Table 7. Simultaneous count totals November 2008 to March 2013.

* 1% EAA = International Significance (threshold of 1% of the estimated population in the East Asian–Australasian Flyway); 0.1% EAA = National significance (threshold of 0.1% of the estimated population in the East Asian–Australasian Flyway; Clemens *et al*. 2010) **Resident shorebird

Species	1% EAA*	0.1%EAA*	Jul-13	Nov-13	Jan-14	Mar-14	Jun-14	Nov-14	Jan-15	Feb-15	Mar-15	Nov-15	Jan-16	Feb-16
Australian Painted Snipe**	**12**		0	0	0	0	0	0	0	0	0	0	0	0
Banded Lapwing**	**270**		0	0	0	0	0	0	0	9	0	0	2	3
Banded Stilt**	**2060**		35	0	**8055**	**8278**	**8176**	**15901**	1863	**9043**	**7088**	**2406**	**13222**	**21352**
Bar-tailed Godwit	**1460**	**146**	0	2	104	12	39	67	118	407	52	90	112	92
Black-fronted Dotterel**	**170**		0	0	0	0	0	0	0	0	0	0	0	0
Black-tailed Godwit	**1390**	**139**	0	0	6	53	0	0	0	2	0	0	1	32
Black-winged Stilt**	**2660**		350	0	180	1299	390	304	119	285	202	128	549	2555
Common Greenshank	**1000**	**100**	0	50	281	113	97	231	227	226	195	168	419	315
Common Sandpiper	**500**	**50**	0	0	1	0	0	0	4	1	0	1	2	2
Curlew Sandpiper	**1350**	**135**	14	0	7	6	196	8	86	261	81	24	77	289
Double-banded Plover	**500**	**50**	0	0	0	1	35	0	0	0	0	0	0	0
Eastern Curlew	**320**	**32**	0	0	12	0	29	33	16	8	5	49	51	40
Great Knot	**2900**	**290**	0	0	2	6	0	4	11	103	2	13	7	17
Greater Sand Plover	**790**	**79**	0	0	2	0	0	0	0	0	0	0	0	0
Grey Plover	**1040**	**125**	0	31	79	164	28	92	154	92	40	112	152	124
Grey-tailed Tattler	**440**	**44**	0	0	10	0	0	4	4	0	0	7	0	1
Latham's Snipe	**250**	**25**	0	0	0	0	0	0	0	0	0	0	0	0
Lesser Sand Plover	**1080**	**108**	0	0	1	0	0	3	8	0	0	0	1	9
Long-toed Stint	**250**	**25**	0	0	0	0	0	0	0	0	0	3	0	0
Marsh Sandpiper	**1000**	**100**	0	0	3	8	2	8	2	19	25	2	6	2
Masked Lapwing**	**2870**		4	42	96		29	94	82	82	127	54	77	185
Pacific Golden Plover	**1000**	**100**	0	2	4	0	0	0	0	1	0	1	0	0
Pectoral Sandpiper	**100**	**10**	0	0	0	0	0	3	0	0	0	1	0	0
Pied Oystercatcher**	**110**	**0**	14	25	49	44	101	43	55	43	45	39	81	89
Red Knot	**990**	**99**	0	3	80	836	30	63	305	1109	388	77	1727	1301
Red-capped Plover**	**950**	**0**	332	363	349	628	1206	465	527	501	270	423	982	2301
Red-kneed Dotterel**	**260**	**0**	0	28	71	83	8	57	0	0	0	51	8	0
Red-necked Avocet**	**1070**	**0**	0	0	80	120	1074	80	0	157	24	0	500	324
Red-necked Stint	**3150**	**315**	440	873	1082	3865	3311	3149	4808	6162	6129	1607	7243	7642
Ruddy Turnstone	**440**	**44**	0	15	24	57	7	48	99	27	68	34	48	120
Ruff	**0**	**0**	0	0	0	0	0	0	0	0	0	0	2	1
Sharp-tailed Sandpiper	**1600**	**160**	0	145	363	757	51	189	439	545	107	488	1406	1521
Sooty Oystercatcher**	**40**	**0**	0	0	5	1	0	14	14	27	44			
Terek Sandpiper	**500**	**50**	0	0	0	0	0	0	0	0	0	19	10	149
Whimbrel	**5500**	**550**	0	0	0	0	0	0	0	6	0	0	0	4
Wood Sandpiper	**100**	**10**	0	0	3	0	0	3	2	0	0	7	4	1
total			**1197**	**1541**	**10895**	**16427**	**7983**	**20841**	**8943**	**19116**	**14892**	**5801**	**26689**	**38471**

Table 8. Simultaneous count totals July 2013 to February 2016.

1% EAA = International Significance (threshold of 1% of the estimated population in the East Asian–Australasian Flyway); 0.1% EAA = National significance (threshold of 0.1% of the estimated population in the East Asian–Australasian Flyway; Clemens *et al*. 2010) **Resident shorebird

Table 9. Species maximums and site they were recorded from known data; historically and in the current project period. Bolded numbers represent significant records at any one *counts area*; *= nationally significant >0.1% EAA, **= internationally significant >1% EAA or >1% total population in the case of resident shorebirds.

Species	maximum count	Site Name	Data source	year	s2020 project max	Site Name	year
Latham's Snipe	3	Dry Creek Saltfields	David Close	1980	2	Magazine Rd	2014
Black-tailed Godwit	**200***	Dry Creek Saltfields (S 3)	Frank Day	1991	41	Dry Creek Saltfields	2008
Bar-tailed Godwit	**1250***	Price Saltfields	David Close	1984	**605***	Thompson Beach	2013
Hudsonian Godwit	1	Dry Creek Saltfields	Frank Day	1988	-	-	-
Little Curlew	3	Price Saltfields	David Close	1982	-	-	-
Whimbrel	70	Price Saltfields	David Close	1986	18	Price Saltfields	2009
Eastern Curlew (CR)	**120***	Clinton CP	David Close	1983	**40***	Port Arthur	2016
Common Redshank	1	Dry Creek Saltfields (S 3)	Frank Day	1983	-	-	-
Marsh Sandpiper	100	Dry Creek Saltfields (S 3)	Frank Day	1995	25	St Kilda	2015
Lesser Yellowlegs	1	Dry Creek Saltfields (S 3)	Frank Day	1990	-	-	-
Common Greenshank	**594***	Price Saltfields	David Close	1995	**216***	Dry Creek Saltfields	2010
Wood Sandpiper	**30***	Dry Creek Saltfields (S 2)	Frank Day	1991	**12***	Magazine Rd	2010
Terek Sandpiper	7	Dry Creek Saltfields	S2020	2009	7	Dry Creek Saltfields	2009
White-rumped Sandpiper	1	Dry Creek Saltfields (S3)	Frank Day	1988	-	-	-
Common Sandpiper	17	Dry Creek Saltfields	David Close	1979	3	Dry Creek Saltfields	2012
Grey-tailed Tattler	38	Middle Beach	David Close	1981	10	Pt Clinton	2014
Ruddy Turnstone	**451****	Price Saltfields	DEWNR	2001	**62***	Macs Beach	2015
Great Knot	**1908***	Price Saltfields	David Close	1990	**800***	Thompson Beach	2010
Red Knot	**2500****	Light Beach	S2020	2009	**2,500****	Light Beach	2009
Sanderling	6	Dry Creek Saltfields	Atlas data		-	-	-
Little Stint	1	Dry Creek and Price	J Cox, D Close & FDay	1979-92	-	-	-
Red-necked Stint	**29,000****	Dry Creek Saltfields	David Close	1981	**7,000****	Dry Creek Saltfields	2008
Long-toed Stint	20	Dry Creek Saltfields	David Close	1980	3	Magazine Rd	2014
Pectoral Sandpiper	6	Buckland Park Lake	Frank Day	1997	3	Magazine Rd	2014
Sharp-tailed Sandpiper	**9800****	Dry Creek Saltfields	David Close	1980	**3,000****	Dry Creek Saltfields	2008
Cox's Sandpiper	1	Dry Creek Saltfields	John Cox	1982	-	-	-
Curlew Sandpiper (CR)	**6,256****	Dry Creek Saltfields	David Close	1984	**600***	Dry Creek Saltfields	2011
Broad-billed Sandpiper	1	Saltfields &Samphire Coast	Various	1979-2004	-	-	-
Ruff	2	Dry Creek Saltfields	David Close		1	Magazine Rd	2013
Red-necked Phalarope	4	Dry Creek Saltfields	Frank Day	1999	-	-	-
Australian Painted Snipe (EN)	**14****	Magazine Rd Wetlands	S2020	2011	**14****	Magazine Rd Wetlands	2011
Pied Oystercatcher	**120****	Section Banks	S2020	2009	**120****	Section Banks	2009
Sooty Oystercatcher	**206****	Section Banks	S2020	2009	**206****	Section Banks	2009
Black-winged Stilt	840*	Dry Creek Saltfields	David Close	1980	402	Dry Creek Saltfields	2011
Red-necked Avocet	1157	Price Saltfields	David Close	1982	500	Price Saltfields	2008
Banded Stilt	**29,110****	Dry Creek Saltfields	David Close	1986	**19,843****	Dry Creek Saltfields	2011
American Golden Plover	1	Dry Creek Saltfields	Collin Rogers	2007	-	-	-
Pacific Golden Plover	32	Price Saltfields	David Close	1981	17	Macs Beach	2013
Grey Plover	**500***	Clinton CP	David Close	1982	80	Port Prime	2009
Ringed Plover	1	Dry Creek Saltfields	Frank Day	1986	-	-	-
Little Ringed Plover	1	Dry Creek Saltfields	Cecil E Rix	1976	-	-	-
Red-capped Plover	**2,100****	Dry Creek Saltfields	David Close	1979	**1,152****	Dry Creek Saltfields	2013
Double-banded Plover	**100***	Price Saltfields	David Close	1981	39	Thompson's Beach	2011
Lesser Sand Plover	25	Clinton CP	David Close	1982	5	Thompson's Beach S	2013
Greater Sand Plover	20	Thompson's Beach	BirdLIfe Atlas	2008	15	Thompson's Beach N	2012
Oriental Plover	2	Dry Creek Saltfields		1981	-	-	-
Inland Dotterel	30	Clinton CP	David Close	1985	-	-	-
Black-fronted Dotterel	50	Dry Creek Saltfields	Frank Day	2010	31	Magazine Rd	2010
Red-kneed Dotterel	**346****	Dry Creek Saltfields	David Close	1985	83	Dry Creek Saltfields	2013
Banded Lapwing	**500****	Clinton CP	David Close		105	Tiddy Widdy - Price	
Masked Lapwing	300	Dry Creek Salfields (S 3)	David Close	1994	94	Dry Creek Saltfields	2013
Oriental Pratincole	1	Dry Creek Saltfields	Frank Day (ref)	1988	-	-	-
Australian Pratincole	20	Dry Creek Salfields (S 3)	Frank Day	1987	-	-	-

Table 10.Simultaneous count results November 2015. Highlighted yellow records denote breeding records

Start Date	3/11/15	3/11/15	24/11/15	24/11/15	27/11/15	27/11/15	28/11/15	10/12/15	1/11/15	2/12/15	3/12/15	3/12/15		3/12/15	3/12/15	23/10/15	
Count Area	Thompson's Beach North	Thompson's Beach South	Barker Inlet Wetlands	Port Prime	Whicker Rd Wetlands	Port Gawler	Magazine Rd	Bolivar	Light Beach	Webb Beach	Saint Kilda	Torrens Island	**Totals NRM region**	Port Clinton	Bald Hill	Port Arthur	**GSV total**
Latham's Snipe	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Black-tailed Godwit	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Bar-tailed Godwit	0	0	0	85	0	0	0	0	0	0	0	0	85	0	5	0	90
Whimbrel	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Eastern Curlew	0	0	0	0	0	8	0	0	0	0	0	0	8	1	0	40	49
Marsh Sandpiper	0	0	2	0	0	0	0	0	0	0	0	0	2	0	0	0	2
Common Greenshank	5	75	4	5	1	0	1	6	25	19	0	2	143	21	4	0	168
Wood Sandpiper	0	0	0	0	1	0	6	0	0	0	0	0	7	0	0	0	7
Common Sandpiper	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	1
Grey-tailed Tattler	0	0	0	0	0	0	0	0	0	0	0	0	0	7	0	0	7
Ruddy Turnstone	15	0	0	3	0	0	0	0	0	0	0	0	18	8	8	0	34
Great Knot	1	0	0	2	0	0	0	0	0	0	0	0	3	10	0	0	13
Red Knot	46	30	0	1	0	0	0	0	0	0	0	0	77	0	0	0	77
Red-necked Stint	0	150	322	186	0	0	0	14	74	106	0	0	852	390	360	5	1607
Long-toed Stint	0	0	0	0	0	0	2	1	0	0	0	0	3	0	0	0	3
Pectoral Sandpiper	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	1
Sharp-tailed Sandpiper	0	0	70	8	6	0	18	3	0	129	0	0	234	39	215	0	488
Curlew Sandpiper	0	0	0	22	0	0	0	0	0	0	0	0	22	2	0	0	24
Ruff	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Australian Painted Snipe	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pied Oystercatcher	17	0	0	7	0	2	0	0	0	0	0	6	32	3	3	1	39
Sooty Oystercatcher	0	0	0	0	0	0	0	0	0	0	10	8	18	1	0	0	19
Black-winged Stilt	0	0	37	0	20	0	3	14	0	0	50	4	128	0	0	0	128
Red-necked Avocet	0	0	0		0	0	0	0	0	0	0	0	0	0	0	0	0
Banded Stilt	0	0	28	758	0	0	0	0	1270	0	350	0	2406	0	0	0	2406
Pacific Golden Plover	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	1
Grey Plover	6	5	0	10	0	0	0	0	0	14	0	0	35	27	50	0	112
Red-capped Plover	3	0	14	97	0	18	5	31	65	62	0	0	295	86	31	11	423
Double-banded Plover	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lesser Sand Plover	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Greater Sand Plover	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Black-fronted Dotterel	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Red-kneed Dotterel	0	0	15	0	20	0	16	0	0	0	0	0	51	0	0	0	51
Banded Lapwing	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Masked Lapwing	5	2	5	4	0	1	0	2	2	11	12	8	52	0	2	0	54
	98	**262**	**497**	**1189**	**49**	**29**	**51**	**72**	**1436**	**341**	**422**	**28**	**4474**	**595**	**678**	**57**	**5801**

Table 11. Simultaneous count results January 2016. Highlighted yellow records denote breeding records

Start Date	25/1/16	25/1/16	14/1/16	28/1/16	29/1/16	29/1/16	30/1/16	30/1/16	5/2/16	11/2/16	11/2/16		31/1/16	1/2/16	
Count Area	Thompson's Beach South	Thompson's Beach North	Bolivar	Whicker Rd Wetlands	Webb Beach	Port Parham	Port Prime	Dry Creek Saltfields	Barker Inlet Wetlands	Saint Kilda	Torrens Island	Totals NRM region	Bald Hill	Clinton CP	GSV total
Latham's Snipe	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Black-tailed Godwit	0	0	0	0	0	0	0	1	0	0	0	1	0	0	1
Bar-tailed Godwit	25	12	0	0	0	0	48	0	0	0	0	85	27	0	112
Whimbrel	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Eastern Curlew	1	0	0	0	0	0	0	4	0	0	0	5	7	39	51
Marsh Sandpiper	0	0	1	0	0	0	0	5	0	0	0	6	0	0	6
Common Greenshank	196	7	29	2	0	0	0	108	6	4	0	352	5	62	419
Wood Sandpiper	0	0	0	1	0	0	0	0	3	0	0	4	0	0	4
Common Sandpiper	0	0	0	1	0	0	0	0	1	0	0	2	0	0	2
Grey-tailed Tattler	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ruddy Turnstone	8	15	0	0	0	0	8	0	0	0	0	31	17	0	48
Great Knot	0	0	0	0	0	0	7	0	0	0	0	7	0	0	7
Red Knot	300	300	0	0	0	0	977	0	0	0	0	1577	150	0	1727
Red-necked Stint	860	200	14	0	170	12	878	3713	120	10	0	5977	160	1106	7243
Long-toed Stint	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pectoral Sandpiper	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sharp-tailed Sandpiper	40	1	438	12	7	1	62	551	50	2	0	1164	229	13	1406
Curlew Sandpiper	50	0	1	0	0	0	23	0	0	0	0	74	0	3	77
Ruff	0	0	1	0	0	0	0	1	0	0	0	2	0	0	2
Australian Painted Snipe	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pied Oystercatcher	25	6	0	0	8	0	38	0	0	0	0	77	3	1	81
Sooty Oystercatcher	0	0	0	0	2	0	0	0	0	0	8	10	0	0	10
Black-winged Stilt	0	0	275	16	0	0	0	208	40	10	0	549	0	0	549
Red-necked Avocet	0	0	0	0	0	0	0	500	0	0	0	500	0	0	500
Banded Stilt	765	0	238	0	0	0	1210	8377	70	2550	0	13210	12	0	13222
Pacific Golden Plover	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Grey Plover	30	5	0	0	5	3	16	0	0	0	0	59	90	3	152
Red-capped Plover	80	0	3	0	7	0	276	535	0	35	0	936	30	16	982
Double-banded Plover	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lesser Sand Plover	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
Greater Sand Plover	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Black-fronted Dotterel	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Red-kneed Dotterel	0	0	0	4	0	0	0	3	1	0	0	8	0	0	8
Banded Lapwing	0	0	0	0	0	2	0	0	0	0	0	2	0	0	2
Masked Lapwing	6	4	13	0	3	0	0	41	6	4	0	77	0	0	77
0	**2386**	**2386**	**550**	**36**	**202**	**0**	**3543**	**14047**	**297**	**2615**	**8**	**24715**	**730**	**1244**	**26689**

Table 12.Simultaneous count results February 2016.Highlighted yellow records denote breeding records

Start Date	22/2/16	22/2/16	22/2/16	23/2/16	24/2/16	24/2/16	24/2/16	25/2/16	25/2/16	27/2/16	29/2/16	29/2/16	2/3/16		1/3/16	1/3/16	24/2/16	22/2/16	22/2/16	
Count Area	Port Gawler	Middle Beach	Port Prime	Port Parham	Dry Creek Saltfields	Thompson's Beach North	Thompson's Beach South	Bolivar	Light Beach	Webb Beach	Saint Kilda	Torrens Island	Section Banks,	Totals NRM region	Bald Hill	Price Saltfields	Macs Beach	Port Arthur	Port Clinton	GSV total
Latham's Snipe	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Black-tailed Godwit	0	0	0	0	32	0	0	0	0	0	0	0	0	32	0	0	0	0	0	64
Bar-tailed Godwit	0	0	0	12	0	0	20	0	0	0	0	0	0	32	28	32	0	0	0	124
Whimbrel	0	0	0	0	0	0	0	0	0	0	0	0	4	4	0	0	0	0	0	8
Eastern Curlew	0	0	0	0	19	0	0	0	0	0	0	0	1	20	11	8	0	0	1	60
Marsh Sandpiper	0	0	0	0	2	0	0	0	0	0	0	0	0	2	0	0	0	0	0	4
Common Greenshank	0	0	1	5	52	2	43	10	30	8	6	4	6	167	60	66	0	0	22	482
Wood Sandpiper	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1
Common Sandpiper	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	1	0	0	0	3
Grey-tailed Tattler	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
Ruddy Turnstone	0	0	0	0	0	35	0	0	1	0	0	0	0	36	19	41	0	0	24	156
Great Knot	0	0	0	0	0	0	0	0	2	0	0	0	0	2	5	0	0	0	10	19
Red Knot	0	0	0	0	0	0	1010	0	10	0	0	0	1	1021	268	12	0	0	0	2322
Red-necked Stint	15	0	0	15	2603	500	300	190	200	240	1800	0	290	6153	203	656	130	200	300	13795
Long-toed Stint	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pectoral Sandpiper	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sharp-tailed Sandpiper	0	0	0	0	132	12	0	41	0	59	550	0	144	938	96	464	0	0	23	2459
Curlew Sandpiper	0	0	0	0	0	0	0	0	2	0	0	0	61	63	4	222	0	0	0	352
Ruff	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	2
Australian Painted Snipe	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pied Oystercatcher	0	0	1	0	0	0	0	0	0	5	4	6	56	72	7	6	0	0	4	161
Sooty Oystercatcher	0	0	0	0	0	1	0	0	0	2	6	30	109	148	0	0	0	0	1	297
Black-winged Stilt	0	0	0	0	904	0	0	146	0	0	1500	0	2	2552	0	3	0	0	0	5107
Red-necked Avocet	0	0	0	0	94	0	0	0	0	0	0	0	0	94	0	230	0	0	0	418
Banded Stilt	0	2	35	0	7185	1	900	1335	3900	8	4000	0	230	17596	16	3740	0	0	0	38948
Pacific Golden Plover	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Grey Plover	0	0	0	0	0	0	3	0	31	19	0	0	39	92	32	0	0	0	0	216
Red-capped Plover	0	0	0	0	982	0	0	10	25	3	450	0	427	1897	30	344	0	10	20	4198
Double-banded Plover	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lesser Sand Plover	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9	0	0	0	9
Greater Sand Plover	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Black-fronted Dotterel	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Red-kneed Dotterel	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Banded Lapwing	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	3
Masked Lapwing	0	2	3	1	81	2	2	15	7	25	12	10	4	164	4	13	0	2	2	349
0	**15**	**4**	**40**	**33**	**12086**	**553**	**2278**	**1748**	**4208**	**369**	**8328**	**51**	**1374**	**31087**	**783**	**5848**	**130**	**215**	**408**	**38471**

2.4 Discussion of S2020 Count Results

This is the ninth year in which Birds South Australia and BirdLife Australia's Shorebirds 2020 Program have cooperated to coordinate simultaneous counts of shorebirds in Gulf St Vincent. Simultaneous counts have been an important factor in reinvigorating the monitoring program across the region and have aided in identifying several internationally and nationally significant areas for shorebirds. They have brought the community together, and have enhanced the mentoring program for new or inexperienced shorebird surveyors. With the finalisation of the boundaries of count areas and an increase in the number of experienced counters, a rapid reduction in the variability of counts should be achieved.

Results from the 2015-16 counts reinforce previous data which identify priority habitats on the Gulf St Vincent as containing one or more species in numbers that are internationally or nationally significant. Even as individual discrete sites these areas classify as "important site" by the definition outlined by the Commonwealth (Section 1.02):

- Dry Creek Saltfields
- Price Saltfields
- Section Bank/Bird Island
- Thompson Beach
- Light Beach
- Port Prime

As a larger complex, the mosaic of sites, which contribute to the Gulf St Vincent "shorebird area" (see pg 72 for definition), exceed several criteria for listing as an internationally significant shorebird habitat (Section 1.02). Important migratory shorebird habitat in Australia is specifically protected under the EPBC Act. Under the Act, approval is required for any action that has, will have, or is likely to have, a significant impact on a matter of national environmental significance, which includes migratory species. An 'action' is broadly defined as a project, a development, an undertaking, an activity or a series of activities, or an alteration of any of these things.

As defined in the EPBC Act Policy Statement 1.1 Significant Impact Guidelines, an action is likely to have a significant impact on a migratory species if there is a real chance or possibility that it will:

- substantially modify (including by fragmenting, altering fire regimes, altering nutrient cycles or altering hydrological cycles), destroy or isolate an area of important habitat for a migratory species
- result in an invasive species that is harmful to the migratory species becoming established in an area of important habitat for the migratory species
- seriously disrupt the lifecycle (breeding, feeding, migration or resting behaviour) of an ecologically significant proportion of the population of a migratory species.

For further information on the application of the EPBC act in relation to shorebirds and shorebird habitat refer to *EPBC Act Policy Statement 3.21—Industry guidelines for avoiding, assessing and mitigating impacts on EPBC Act listed migratory shorebird species, Commonwealth of Australia 2015.* *https://www.environment.gov.au/system/files/resources/67d7eab4-95a5-4c13-a35e-e74cca47c376/files/shorebirds-guidelines.pdf*

Although there is some variation between count totals for simultaneous counts (further discussed below) and totals listed in (table 7 and 8) can't account for the entire Gulf St Vincent population, they are very useful in identifying population abundance minimums. From these counts we can assume that the current condition of habitats within the gulf sufficiently provides for around 20,000-40,000 shorebirds. Of note:

- Several natural sites within the Samphire Coast regularly support nationally (>0.1% EAA) or internationally (>1% EAA) significant number of coastal obligates Red Knot Red and Bar-tailed Godwit (individual species accounts in Section 1.03a). These species are heavily reliant on feeding (intertidal mudflat) and roosting habitat (sandy shores, shellgrit islands and floating accumulations of wrack) between Light Beach and Bald Hill. Given their specific requirements and the finite amount of available intertidal habitat, these populations should be management priorities in the area. Increasingly inconsistent recording of these species at regular roost sites in Port Prime and Thompsons Beach suggest some behavioural shifts. Tendencies for these large flocks to more frequently roost at Bald Hill and the Price Saltfields may be a reaction to increased disturbance at Thompsons Beach from crabbers and other recreational visitors.
- The Dry Creek Saltfields has maintained high abundances of species despite changes to the operational hydrology. As with ephemeral wetlands, the transitioning of ponds from wet to dry has provided temporary increases in available feeding and roosting areas (further discussed in Section 1.03 (a)).
- Isolated areas (Section Banks, Thompson Beach north claypans, Dry Creek Saltfields) remain priority breeding areas for Red-capped Plovers and Pied Oystercatchers. Section Banks also regularly supports populations of breeding Sacred Ibis, Australian Pelican, Eastern Great Egret, Crested Tern and the 'vulnerable' Fairy Tern. Management of these areas should seek to accommodate the specific needs of these populations.

a) Species accounts for significant populations

The following accounts of significant pollutions occurring within Gulf St Vincent.

Notes on Listings
The following species accounts refer to the latest available information on conservation status and population size that has been compiled both on a global scale and for the proportion of the species using the EAAF. They include:

- Conklin, J.R., Y.I. Verkuil & B.R. Smith. 2014. Prioritizing Migratory Shorebirds for Conservation Action on the East Asian-Australasian Flyway WWF-Hong Kong, Hong Kong
- BirdLife International. 2015. Species factsheets: IUCN Red List for birds
- Guidelines for Application of IUCN Red List Criteria at Regional and National Levels; Version 4.0
- Watkins, D., R. Jaensch, D. Rogers & Gosbell. 2012. Preliminary updated estimates of population size of selected shorebird species in the East Asian Australasian Flyway based on trends in The Action Plan for Australian Birds 2010 (Garnett et al.2011)

Bar-tailed Godwit *Limosa lapponica*: Both subspecies of Bar-tailed Godwit (*menzbieri* and *baueri*) are considered to occur in Gulf St Vincent however there is no detail on what proportions of each. A combined population estimate for both subspecies is referenced in this report.

Red Knot *Calidris canutus*: It is not known which subspecies of Red Knot (*piersmai* or *rogersi*) occurs in Gulf St Vincent. A combined population estimate for both subspecies is referenced in this report.

i) Group B Criterion 2: A wetland should be considered internationally important if it supports vulnerable, endangered, or critically endangered species or threatened ecological communities.

Nine shorebird species listed as threatened under the EPBC have been observed in the Northern Gulf St Vincent (Table 16). The area regularly supports nationally significant numbers (0.1% EAAFP) of 2 globally Endangered species (IUCN Red List):

- Eastern Curlew *Numenius Madagascariensis*
- Great Knot *Calidris tenuirostris*

2 species found to be regionally Vulnerable (IUCN Red List) in the EAA Flyway (Conklin et al 2014):

- Bar-tailed Godwit *Limosa lapponica*
- Curlew Sandpiper *Calidrius leschenaultii*.

The site also regularly supports internationally significant (>1% EAAFP) numbers of 1 regionally Vulnerable (IUCN Red List) in the EAA Flyway (Conklin et al 2014):

- Red Knot *Calidris canutus*

ii) Group B Criterion 6: A wetland should be considered internationally important if it regularly supports 1% of the individuals in a population of one species or subspecies of waterbird.

The Northern Gulf St Vincent regularly supports internationally significant populations of two species of migratory waterbird; Red Knot *Calidris canutus* and Red-necked Stint *Calidris ruficollis*.

Red Knot *Calidris canutus*
As discussed it is not clear which subspecies of Red Knot occurs in Gulf St Vincent, the latest

combined 1% threshold for the two subspecies is 990 birds. This threshold was exceeded in 7 of the last 8 years (Table 13).

Table 13. Population count data for Red Knot in Gulf St Vincent (2008-2016).

Summer	Max Count	date
2008/09	**1637**	28/02/2009
2009/10	**1103**	23/01/2010
2010/11	**1615**	12/03/2011
2011/12	**1095**	2/02/2012
2012/13	**2055**	5/12/2012
2013/14	836	17/03/2014
2014/15	**1109**	2/02/2015
2015/16	**1291**	22/02/2016

Red-necked Stint *Calidris ruficollis*
The latest 1% threshold is 3,150 birds. The threshold was exceeded in 6 of the last 8 years (Table 14).

Red-necked Stints regularly occur in internationally significant numbers (>1% EAAFP) at the Dry Creek saltfields. As the largest supratidal area of habitat in Gulf St Vincent Red-necked Stints use the saltfields as a supplementary high-tide feeding and roosting site. Given counts in Gulf St Vincent are predominantly conducted at high-tide roosts they do not completely account for habitat usage at all tide heights and a proportion of the birds that are counted at the saltfileds are considered to move to nearby intertidal areas on a falling tide.

Table 14. Population count data for Red-necked Stint in Gulf St Vincent (2008-2016).

Summer	Max Count	date
2008/09	**11,791**	28/02/2009
2009/10	**6,749**	23/01/2010
2010/11	2927	12/03/2011
2011/12	3,123	9/11/2011
2012/13	**4070**	1/12/2012
2013/14	**3865**	17/03/2014
2014/15	**6162**	2/02/2015
2015/16	**7834**	22/02/2016

*NB: A single count of 2,200 Red-necked stints was made on the coastline adjacent to the Port Wakefield Proof and Experimental Range in 2011. This one incidental count exceeded the accumulative count for all other sites on the simultaneous count for that season. Due to access restrictions enforced by the Department on Defence, this area has only been counted twice in the last decade.

Sharp-tailed Sandpipers *Calidris acuminata*
Although more variable in their abundance depending on large scale water availability Sharp-tailed Sandpiper regularly occur within the Gulf St vincent in nationally significant numbers (>160) and

have occurred in the site at nationally significant numbers (>1,600) twice in the last 8 years. These events occurred during the millennium drought and highlight the significance of the Dry Creek Saltfields and the gulfs coastal wetlands as drought refugia.

Table 15. Population count data for Sharp-tailed Sandpiper in Gulf St Vincent (2008-2016).

Summer	Max Count	date
2008/09	**3,224**	28/2/2009
2009/10	**3,120**	23/1/2010
2010/11	0	12/3/2011
2011/12	79	9/11/2011
2012/13	1,103	1/12/2012
2013/14	757	17/3/2014
2014/15	545	21/2/2015
2015/16	1,530	22/2/2016

Count variation

A comparison of results from the six simultaneous counts conducted since 2008 provides an insight into the variation one might expect from repeated counts in Gulf St Vincent (Table 1). There are three possible sources of discrepancies: (1) shorebirds' behavioural variation; and (2) count error (3) incomplete coverage.

A high variation in counts, such as that observed in Australian resident species (i.e. those that breed in Australia) including Banded Stilts and Red-necked Avocets, suggests that these shorebirds may move in and out of the study area, which is inconsistent with the concept of a shorebird area in which birds remain over the peak summer months. This is perhaps not surprising considering the life histories of these species.

These shorebirds are generally associated with sudden, episodic increases in the availability of prey in coastal or inland wetlands. Their use of flooded inland habitats is often opportunistic, and sudden inland flooding sometimes results in rapid and dramatic breeding events involving a large proportion of the population. For example, this occurred in winter 2010, when 150,000 Banded Stilts descended on Lake Torrens to breed, with an estimated 200,000 chicks hatching. Many of these birds reportedly remained in nearby pastoral areas, where they bred again seven months later when water generated from Tropical Cyclone 'Yasi' once again inundated Lake Torrens. On this occasion, an estimated 25,000 Banded Stilts were observed at the site. In 2011–12, nearly 20,000 Banded Stilts returned to the eastern shores of Gulf St Vincent.

Similarly, some migratory shorebirds, such as the Sharp-tailed Sandpiper, are thought to utilise episodic flood events which may save them a flight of more than 150 kilometres further south to terminal non-breeding sites on Australia's southern coastline. This event was reflected in a 98 per cent decline in Sharp-tailed Sandpipers recorded in the Gulf between January 2010 and January 2011. Such events may account for some of the natural variation in counts which occurs over short time scales. In the 2014-15 season increased salinities at the Dry Creek saltfields promoted an increased biomass (largely brine fly larvae) in Section 3 ponds.

The second cause of variation in counts stems from incomplete or excessive count coverage. For example, the numbers of Pied and Sooty Oystercatchers recorded in 2008 and 2011 were low and probably did not capture the whole population. This possibly arose because Section Bank/Bird Island, where most oystercatchers were recorded in the intervening surveys, was not surveyed in 2008 and 2011. Similarly, large numbers of Common Greenshanks, Red-capped Plovers, Sharp-tailed

Sandpipers and Red-necked Stints were recorded in 2009; these numbers were inflated by a survey which was conducted at low-tide, while birds were feeding on the extensive mudflats of the Clinton Conservation Park, and may have resulted in double counts of birds that roosted at high tide in nearby count areas, such as Price Saltfields.

Variation in counts of small, common waders, such as Red-capped Plovers, Red-necked Stints and Sharp-tailed Sandpipers, may also be caused by difficulties in surveying areas of high shorebird abundance and diversity, such as Dry Creek Saltfields, where the sheer number of birds makes it difficult to count them. Due to the supratidal nature of such sites, birds may remain feeding throughout the day, and often move throughout the salt ponds to access different feeding and roosting areas. This sometimes results in either double counts or birds not being counted at all. To reduce this problem, counters work in teams, with the counting of a common species delegated to one person who is more able to keep track of movements and overall abundance. In addition, counters are encouraged to collect data which allows the completeness of a count to be assessed.

Total maximum counts of conspicuous species (such as Bar-tailed Godwits and Red Knots), which occur mainly on the northern beaches and Price Saltfields have shown remarkable consistency in the total number observed in each complete survey of Gulf St Vincent to date. These results are encouraging as they demonstrate that with consistent coverage, sufficient counter experience and standardised methods, resulting data will have notably less variation than observed in previous shorebird surveys in Gulf St Vincent.

By considering the average maximum of birds counted at each site across the 8 year study period we can better understand how shorebird populations are using sites and what their requirements are. Table 16 and the species maps found in Appendix 2 further reinforce the significance of the northern Samphire Coast (Light Beach to Bald hill), the two saltfields and the Section Banks. These sites not only support the highest diversity and abundances of shorebirds abundance but also provide habitat for threatened migratory species.

Count area	Max Avg total shorebirds	shorebird diversity	EPBC listed Species	Austrlaian Painted Snipe	Lesser Sand Plover	Greater Sand Plover	Black-tailed Godwit	Bar-tailed Godwit	(Far) Eastern Curlew	Great Knot	Red Knot	Curlew Sandpiper
				E	E	V	V	CE * / V	CE	CE	E	CE
Bald Hill	984	20	6			2		1	1	1	1	1
Barker Inlet Wetlands	446	14	1									x
Bolivaar*	1748	13	1									x
Clinton CP	740	10	3		1				1			1
Dry Creek Saltfields	26019	24	4				1	1	1			1
Light Beach	5959	19	5					1	1	1	1	1
Magazine Rd	271	16	1	2								
Middle Beach	73	9	0									
Port Arthur	122	19	5					1	1	2	2	1
Port Clinton	984	21	7		2		1	2	1	2	1	1
Port Gawler	641	4	5		2			2	1		2	1
Port Parham	216	20	5		2			1		2	1	1
Port Prime	2316	15	6			2		1	1	1	1	1
Price Saltfields	7465	21	6		2			1	1	1	1	1
Saint Kilda	3611	21	4				2	2	2			1
Section Banks	1206	18	5					1	1	2	2	1
Thompson's Beach N	1372	25	8		2	2	2	1	1	1	1	1
Thompson's Beach S	3010	23	6		2			1	1	1	1	1
Webb Beach	667	11	6		2	2		1	1		1	1
Black Point	100											
Price coast (Mac's Beach)	29	15	5				2	1		2	1	1
Whicker Rd Wetlands	32	13										
White's Rd Wetlands	15	14	1	2								

Table 16. A summary of site data generated from count data collected in simultaneous counts during the study period. The maximum average count is calculated from the maximum count of each species observed at each site each season averaged over the amount of seasons that site was covered. For threatened species records "1" denotes species that are regularly observed at the site "2" denotes irregular visitors. *Bolivar maximums are based on a single season of counts conducted by G. Carpenter in the 2015/16 summer.

Birds South Australia and its volunteers should be commended for their excellent efforts in continuing to undertake shorebird monitoring in Gulf St Vincent. Although the advent of the Shorebirds 2020's online data entry portal will be beneficial in the long run, it has also caused initial coordination confusion as some observers circumnavigate the regional coordinator, which allows less chance for feedback, accountability and retention. BirdLife Australia must continue to work closely with regional coordinators and counters in the future to overcome this shortfall. To further reduce the variation between counts, which would enable researchers to detect population trends more quickly, a number of refinements could be made:

BIRDLIFE AUSTRALIA RECOMMENDATIONS

58. Conduct surveys at the same time of year each year. This ensures that site conditions are similar each time and further increases the chances of counting the same group of birds.

59. Conduct surveys within a tighter time-frame, both within the week and within daily tide cycles, especially at proximate sites where there is a frequent exchange of birds. Provide volunteers with up-to-date maps, marked with the boundaries of count areas, to ensure that the areas being surveyed remain consistent.

60. Foster good count and identification techniques among counters through workshops and mentoring.

61. Continue conducting twice-yearly shorebird workshops to increase awareness of shorebird conservation and to expand the pool of experienced volunteer surveyors.

62. Develop an understanding of how well monitoring informs adaptive management, and optimise monitoring to inform on threats as our understanding of the severity and the distribution of threats increases.

63. Conduct field trips and counts with experienced mentors to foster appropriate count methods and familiarise new counters with shorebird identification and shorebird count areas.

64. Scope opportunities for local stakeholders and operational staff to conduct surveys.

3. *EVENTS*

3.1 Shorebird Training and Education

In the 2014–15 season (spring–summer), a number of shorebird events where conducted in collaboration with the AMLR NRM Board and BirdLife Australia's Samphire Coast Icon Project and a banding expedition conducted by the Victorian Wader Study Group (VWSG) and Friends of Shorebirds SE and NR AMLR staff on behalf of AMLR NRM Board (Table 17). The events are broadly aimed at varying demographics to educate local communities and land managers about shorebird conservation and equip them with the identification skills and survey methodologies necessary to contribute to the Gulf St Vincent Population Monitoring Project. Topics covered included:

- The responsibilities and achievements of the Adelaide and Mount Lofty Ranges Natural Resources Management Board's coastal division;
- Shorebird ecology (migration, physiology, habitat requirements);
- Shorebird threats and conservation priorities (threats, population trends, mitigating against decline);
- The Shorebirds 2020 program;
- A review of outcomes achieved through the Gulf St Vincent Population Monitoring Project
- An introduction to shorebird ID and effective monitoring techniques;
- The use of optics.

Figure 45. Workshop participants hear BirdLife Australia's Dr Golo Maurer discusse the significance of Gulf St Vincent in the context of the International Important Bird Area network. Barker Inlet 28/11/2015.

Table 17. Shorebird events BirdLife conducted or contributed to during the 2014–15 season. Population monitoring project events bolded.

Date	Event information	Target group	Duration (hrs)	Participation (Excl staff)	New Participants
13-14/8/2015	**AIBS Ecology Forum Presentation to forum & facilitate Day 2 workshops,**	**Environmental Management**	**0.5**	**200**	**150**
20/08/2015	Beach-nesting Birds Teacher training	Education (train the trainers)	2	12	11
22/8/2015	Red-capped Plover Workshop & monitoring season launch	Citizen Science - Community volunteers	3	33	24
12/09/2015	Shorebirds Lantern-making Workshop	General Community	3	21	15
13/09/2015	Tennyson Dunes Open Day,	Community Volunteers & General Community	0.5	12	12
21– 27/9/2015	Red-capped Plover Monitoring week	Citizen Science – Community Volunteers	2 (x21)	21	0
27/09/2015	OzAsia Moon Lantern Parade Red Knot Lantern	General Community	2.5	42 (Knot team) 50,000 public	28
7-8/10/2016	**Shorebird Ecology & ID Volunteer training for Flyway Festival (2 sessions)**	**Community Volunteers**	**2.5**	**17**	**9**
17/10/2015	Adelaide Flyway Festival, Shorebirds Nature Trail, St Kilda	General Community	6	500	
17/10/2015	**Adelaide Flyway Festival, Introduction to Shorebirds**	**General Community**	**2**	**60**	**50**
17/10/2015	Adelaide Flyway Festival, Selfie with a Shorebird, St Kilda,	General Community	6	100	80
21/10/2015	Aussie Backyard Bird Count:– Shorebirds & Waterbirds, Fulham Seascouts	Education & General Community	2	26	26
12-13/11/2015	SA Coastal Conference, West Beach	Environmental Management & Research	0.5	40	
27/11/2016	**1st simultaneous summer count shorebird population monitoring**	**S2020 volunteers**	**4 (x15)**	**15**	**3**
28/11/2015	**"Shorebirds 101", Identification in the Field, Barker Inlet Wetlands**	**Citizen Science – Community Volunteers**	**4**	**17**	**6**
29/11/2015	**"Shorebirds 101", Identification in the Field, Thompson Beach**	**Citizen Science – Community Volunteers**	**3**	**5**	**2**
30/11 – 6/12/2015	Red-capped Plover Monitoring week	Citizen Science – Community Volunteers	2	22	
16– 18/12/2015	Red-capped Plover Banding – Volunteer Field work,	NRM Research and Citizen Science – Community Volunteers	4	2 (plus 4 project trainees)	0
13 – 15/1/2016	Red-capped Plover Banding – Volunteer Field work,	Community	30	3	0
14/01/2016	Dog's Dinner – RCP Awareness stand, Semaphore South,	Community	2	20	17
15/01/2016	Dog's Breakfast – RCP Awareness stand, Semaphore South,	Community	2	15	12
27/01/2016	AIBS Community Consultation presentations (4 locations)	Community	8	147	110
29/01/2016	**2nd simultaneous summer count shorebird population monitoring**	**S2020 volunteers**	**4 (x15)**	**15**	**0**
24/02/2016	**3rd simultaneous summer count shorebird population monitoring**	**S2020 volunteers**	**4 (x16)**	**16**	
27/02/2016	**Shorebird Ecology & ID Workshop: AIBS Collective & DEWNR support staff training**	**Agency & Community**	**3.5**	**23**	**15**
28/02/2016	**Shorebird Ecology & ID Workshop: general community, Thompson Beach**	**Community**	**3.5**	**18**	**8**
4/04/2016	Junior Dolphin Rangers – Shorebird training, Red-capped Plovers	Education/Community	1.5 (5 sessions)	140	140
9-13/3 & 5– 9/4/2016	Migratory Shorebird banding, Samphire Coast,	Community (FoSSE & VWSG and local volunteers).	9 days	15	0
23/03/2016	Samphire Coast Familiarisation Tour – Gawler NR Office staff	Agency	5.5	12	5
1/04/2016	Red-capped Plover Monitoring season Wind-up,	Community	2.5	27	1
19/04/2016	Zoos SA YATZ group Shorebirds presentation & field trip	Community (Youth group)	2.5	25	25
10/06/2016	World Migratory Birds Day Film Night, Adelaide (led by DEWNR AIBS Team)	Community	3.5	150	105
7/6/2016	Wetland Walk, Magazine Road (Greenfields Stage 3) Wetlands	Community	2	14	7

Online survey feedback from previous shorebird workshops had indentified that the majority of ‘beginner’ and ‘intermediate’ shorebirders required more time spent on the identification training. With this in mind, much time in each session was dedicated to working through the diagnostic characteristics, behaviour and typical habitat choices of the 30 most common shorebird species that occur in Gulf St Vincent. Presentation materials were also supplemented with shorebird identification booklets and access to the Oz Shorebird app which can be viewed on all smartphones.

Effectiveness of recruitment, coordination and submission of data

The main goals of the workshops were to: (1) increase awareness of shorebird conservation; (2) recruit counters to the shorebird monitoring program; and (3) train them as counters.

When the Gulf St Vincent monitoring program began in 2008, approximately 80 counters were recruited to monitor shorebirds in Gulf St Vincent in the summer of 2009–10. This was a marked increase in the number of counters who participated the previous summer, and resulted in the most comprehensive survey coverage in Gulf St Vincent so far. However, volunteer participation in the 2010–13 counts declined drastically. On a coordination level, insufficient follow-up of volunteers in the lead-up to the season probably contributed to the poor levels of participation. Shorebirds 2020’s move towards online data entry has also caused some confusion for coordinators, as counters submit their counts directly to BirdLife Australia. By circumventing contact with the coordinator at the data submission point, it becomes difficult to keep track of which observers have conducted surveys and have submitted their data, and which areas have been covered.

REFERENCES and additional resources

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APPENDIX A: Shorebird count form

SHOREBIRD COUNT FORM

birdlife AUSTRALIA · AWSG · CARING FOR OUR COUNTRY

OFFICE USE
VISIT ID:

OBSERVER DETAILS *For detailed instructions on how to fill out this form refer to "Count Form Instructions"*

FULL NAME: ______ PHONE NUMBER: ______

If more than one observer, only name the count leader or main contact

EMAIL: ______ TOTAL NO. OBSERVERS ______ YEARS OF COUNTING EXPERIENCE OF MOST EXP. COUNTER ______

TIME & DATE

SURVEY DATE: DAY / MONTH / YEAR

TIME STARTED: *(24 hour clock)* HOUR / MINS

TIME FINISHED: *(24 hour clock)* HOUR / MINS

SURVEY DETAILS

IF COUNT ***WAS*** CONDUCTED IN A SHOREBIRDS 2020 COUNT AREA
(count area names and maps available at www.shorebirds.org.au)

SHOREBIRD AREA ______ COUNT AREA ______ COMPLETE COVERAGE OF MAPPED COUNT AREA? YES or NO

OR

IF COUNT WAS ***NOT*** CONDUCTED IN A SHOREBIRDS 2020 COUNT AREA:

SITE NAME ______ LAT/ LONG ______

STATE ______ SURVEY TYPE *(land, boat, air)* L,B,A ______ TIDE HEIGHT *Height in metres or rising, high, falling or low* ______ AREA UNDER WATER *(wetlands only)* % ______ WIND DIRECTION *E.g. N, NE, NNE* ______

WIND SPEED
- ◯ 0 - 5 kph *(flat to ripples / wind not felt on face)*
- ◯ 6 - 11 kph *(small wavelets, crests not breaking / wind felt on face)*
- ◯ 12 - 19 kph *(large wavelets, crests begin to break / leaves in motion)*
- ◯ 20 - 28 kph *(small waves / dust, small*
- ◯ 29 - 38 kph *(moderate waves, some foam & spray / small trees sway)*
- ◯ 39 - 49 kph *(large waves with foam,crests and spray / large branches in motion)*
- ◯ >50 kph *(sea heaps up, foam beings to streak / strong resistance while walking)*

HUMAN ACTIVITY *Write down the number of times the following were observed during the count within the count area:*

PEOPLE MOVING		BOATS - AT ANCHOR		JET SKI	
PEOPLE FISHING		BOATS - MOVING		ATV/MOTORCYCLE	
DOGS - OFF LEAD		BOATS - WATERSKIING		CARS/TRUCKS	
DOGS - ON LEAD		BOATS - VERY LOUD/FAST		OTHER *(specify)*	

NUMBER OF FLIGHTS CAUSED BY DISTURBANCE: ______

THREATS *Add timing, scale and severity scores to obtain a total threat score for each threat type*

TIMING	SEVERITY	SCALE	TOTAL THREAT SCORES
3 = Occurring now	3 = Will persist for >10 years	3 = >90% population decline	0-5 = Low threat
2 = Likely to occur within 1-3 years	2 = Will persist for 3-10 years	2 = 50-90% population decline	6-7 = Medium threat
1 = Likely to occur in >3 years	1 = Will persist for 0-3 years	1 = 10-49% population decline	8-9 = High threat
0 = Not occuring, not likely to in future	0 = Will not persist	0 = 0-9 % population decline	

	TIMING		SEVERITY		SCALE		TOTAL
HABITAT LOSS		+		+		=	
HUMAN DISTURBANCE		+		+		=	
INVASIVE SPECIES		+		+		=	
POLLUTION		+		+		=	
WATER LEVEL		+		+		=	

HABITAT CHANGE

HAS HABITAT CHANGED SINCE LAST COUNT?: YES or NO ______

AREA AFFECTED BY HABITAT CHANGE: *(area used by shorebirds only)* % ______

TYPE OF HABITAT CHANGE: *(mark all that apply)*
- URBAN DEVELOPMENT (within 200m) ◯
- RECLAMATION ◯
- HARVESTING/FISHING ◯
- FISH FARMING/AQUACULTURE ◯
- CHANGE IN WATER LEVELS ◯
- EROSION ◯
- POLLUTION ◯
- ENCROACHMENT FROM NATIVE VEGETATION ◯
- INVASIVE SPECIES/INTRODUCED PESTS ◯
- ALGAL BLOOMS ◯

Count forms, count area maps, instructions at www.shorebirds.org.au. Return form to Shorebirds 2020, Birds Australia, 60 Leicester Street, Carlton, Victoria, 3053. Ph (03) 9347 0757. Email: shorebirds@birdsaustralia.com.au.
Online data entry form at http://data.shorebirds.org.au/

SHOREBIRDS

Ⓑ = breeding: please enter comments below
Enter 'P' for present in box where a species was present but not counted

STONE-CURLEWS

- Ⓑ Bush Stone-curlew
- Ⓑ Beach Stone-curlew

OYSTERCATCHERS, STILTS

- Ⓑ Aust. Pied Oystercatcher
- Ⓑ Sooty Oystercatcher
- Ⓑ Black-winged Stilt
- Ⓑ Red-necked Avocet
- Ⓑ Banded Stilt

PLOVERS, DOTTERELS, LAPWINGS

- Pacific Golden Plover
- Grey Plover
- Little Ringed Plover
- Ⓑ Red-capped Plover
- Double-banded Plover
- Lesser Sand Plover
- Greater Sand Plover
- Oriental Plover
- Ⓑ Black-fronted Dotterel
- Ⓑ Hooded Plover
- Ⓑ Red-kneed Dotterel
- Ⓑ Banded Lapwing
- Ⓑ Masked Lapwing

JACANA, PAINTED SNIPE, SNIPE

- Ⓑ Comb-crested Jacana
- Ⓑ Australian Painted Snipe
- Latham's Snipe
- Other Gallinago sp.

GODWITS, CURLEWS, SANDPIPERS, ALLIES

- Black-tailed Godwit
- Bar-tailed Godwit
- Little Curlew
- Whimbrel
- Eastern Curlew
- Terek Sandpiper
- Common Sandpiper
- Grey-tailed Tattler
- Wandering Tattler
- Common Greenshank
- Marsh Sandpiper
- Common Redshank
- Wood Sandpiper
- Ruddy Turnstone
- Asian Dowitcher
- Great Knot
- Red Knot
- Sanderling
- Red-necked Stint
- Long-toed Stint
- Pectoral Sandpiper
- Sharp-tailed Sandpiper
- Curlew Sandpiper
- Broad-billed Sandpiper
- Ruff
- Red-necked Phalarope

PRATINCOLES

- Oriental Pratincole
- Ⓑ Australian Pratincole

UNIDENTIFIED

- *Unident. small wader*
- *Unident. med. wader*
- *Unident. large wader*

GEESE, DUCKS, SWANS, GREBES

- Ⓑ Magpie Goose
- Ⓑ Plumed Whistling-duck
- Ⓑ Musk Duck
- Ⓑ Cape Barren Goose
- Ⓑ Black Swan
- Ⓑ Australian Shelduck
- Ⓑ Australian Wood Duck
- Ⓑ Pink-eared Duck
- Ⓑ Australasian Shoveler
- Ⓑ Grey Teal
- Ⓑ Chestnut Teal
- Ⓑ Northern Mallard
- Ⓑ Pacific Black Duck
- Ⓑ Hardhead
- Ⓑ Blue-billed Duck
- Ⓑ Australasian Grebe
- Ⓑ Hoary-headed Grebe
- Ⓑ Great Crested Grebe

GANNETS, CORMORANTS

- Ⓑ Australasian Gannet
- Ⓑ Australasian Darter
- Ⓑ Little Pied Cormorant
- Ⓑ Great Cormorant
- Ⓑ Little Black Cormorant
- Ⓑ Pied Cormorant
- Ⓑ Black-faced Cormorant

PELICAN, HERONS, ALLIES

- Ⓑ Australian Pelican
- Ⓑ White-necked Heron
- Ⓑ Eastern Great Egret
- Ⓑ Intermediate Egret
- Ⓑ Cattle Egret
- Ⓑ White-faced Heron
- Ⓑ Little Egret
- Ⓑ Nankeen Night Heron
- Ⓑ Glossy Ibis
- Ⓑ Australian White Ibis
- Ⓑ Straw-necked Ibis
- Ⓑ Royal Spoonbill
- Ⓑ Yellow-billed Spoonbill
- Ⓑ Purple Swamphen
- Ⓑ Dusky Moorhen
- Ⓑ Eurasian Coot

GULLS, TERNS

- Ⓑ Little Tern
- Ⓑ Fairy Tern
- Ⓑ Caspian Tern
- Ⓑ Whiskered Tern
- Ⓑ White-fronted Tern
- Ⓑ Common Tern
- Ⓑ Crested Tern
- Ⓑ Pacific Gull
- Ⓑ Kelp Gull
- Ⓑ Silver Gull

EXTRA BIRDS NOT LISTED ABOVE

- Ⓑ
- Ⓑ
- Ⓑ
- Ⓑ

TOTAL BIRDS

- *Total shorebirds*
- *Total other birds*

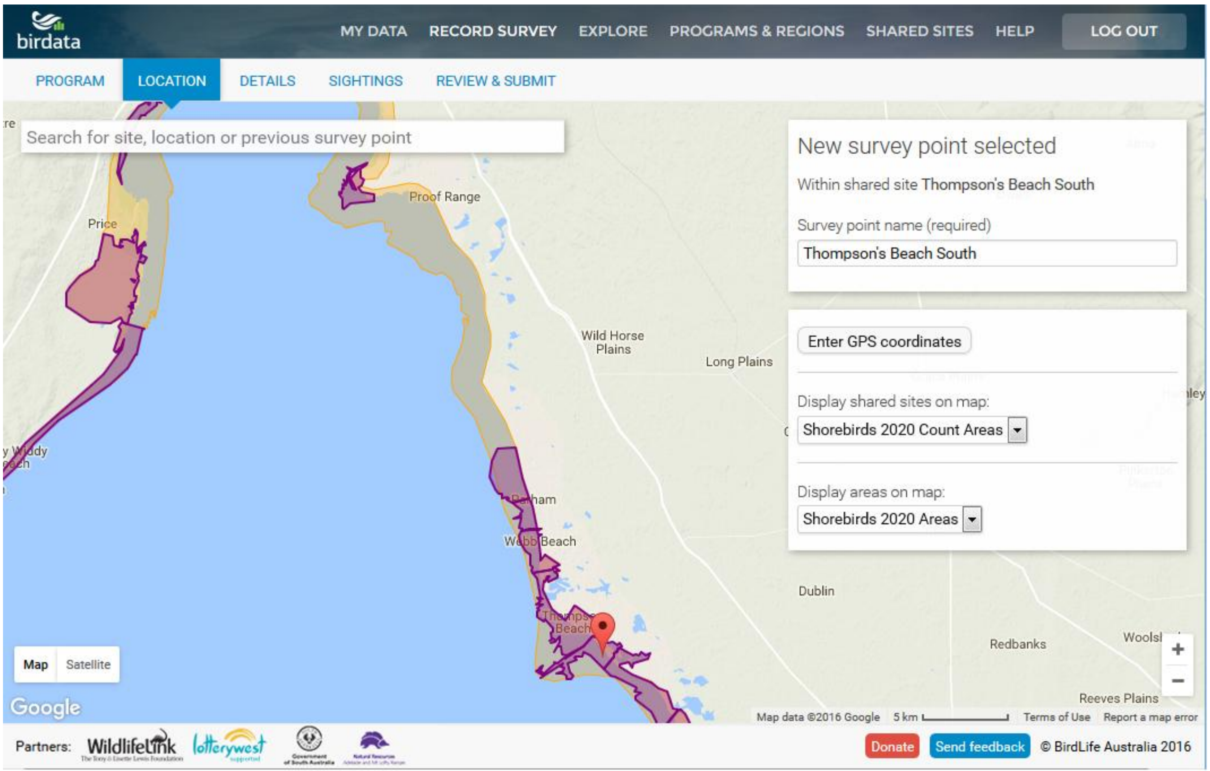
COMMENTS

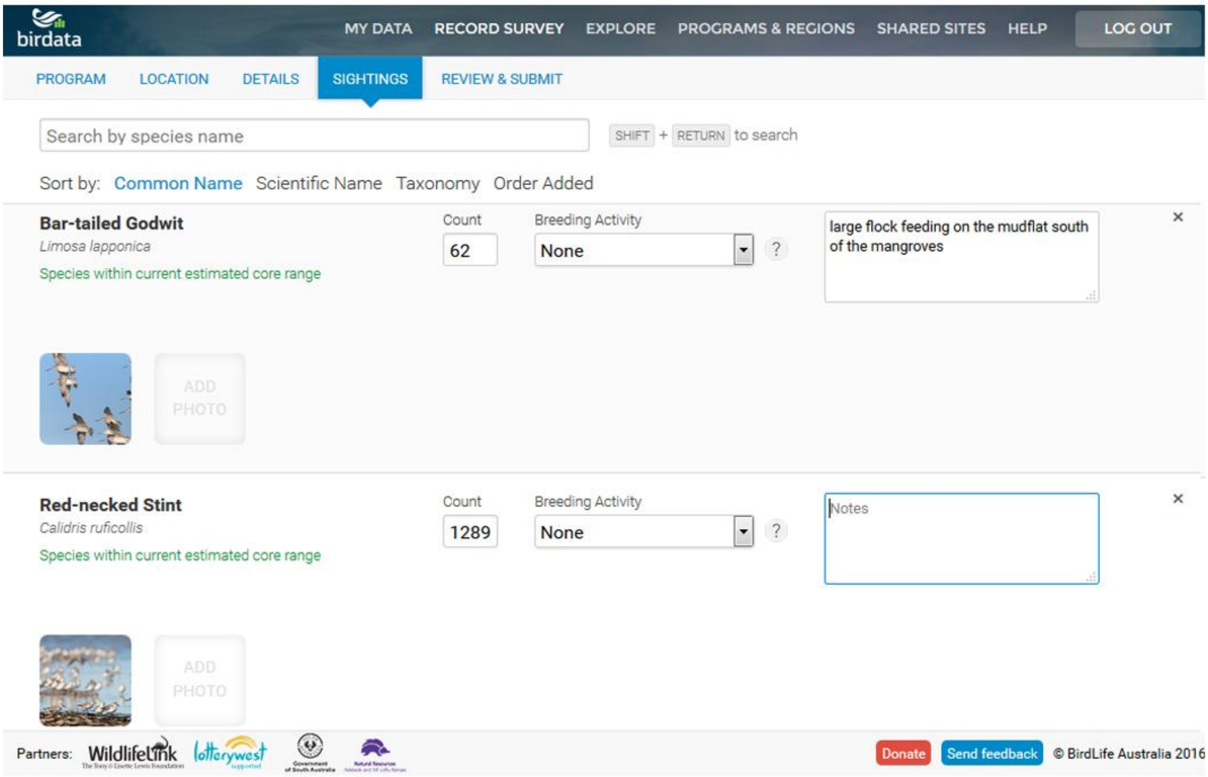
Enter comments, extra species counts, presence of dead birds, details of habitat change, disturbances and threats here. Attach additional pages if necessary.

WERE ALL VISIBLE SHOREBIRDS COUNTED? YES or NO

WERE ALL WATER BIRDS COUNTED? YES or NO

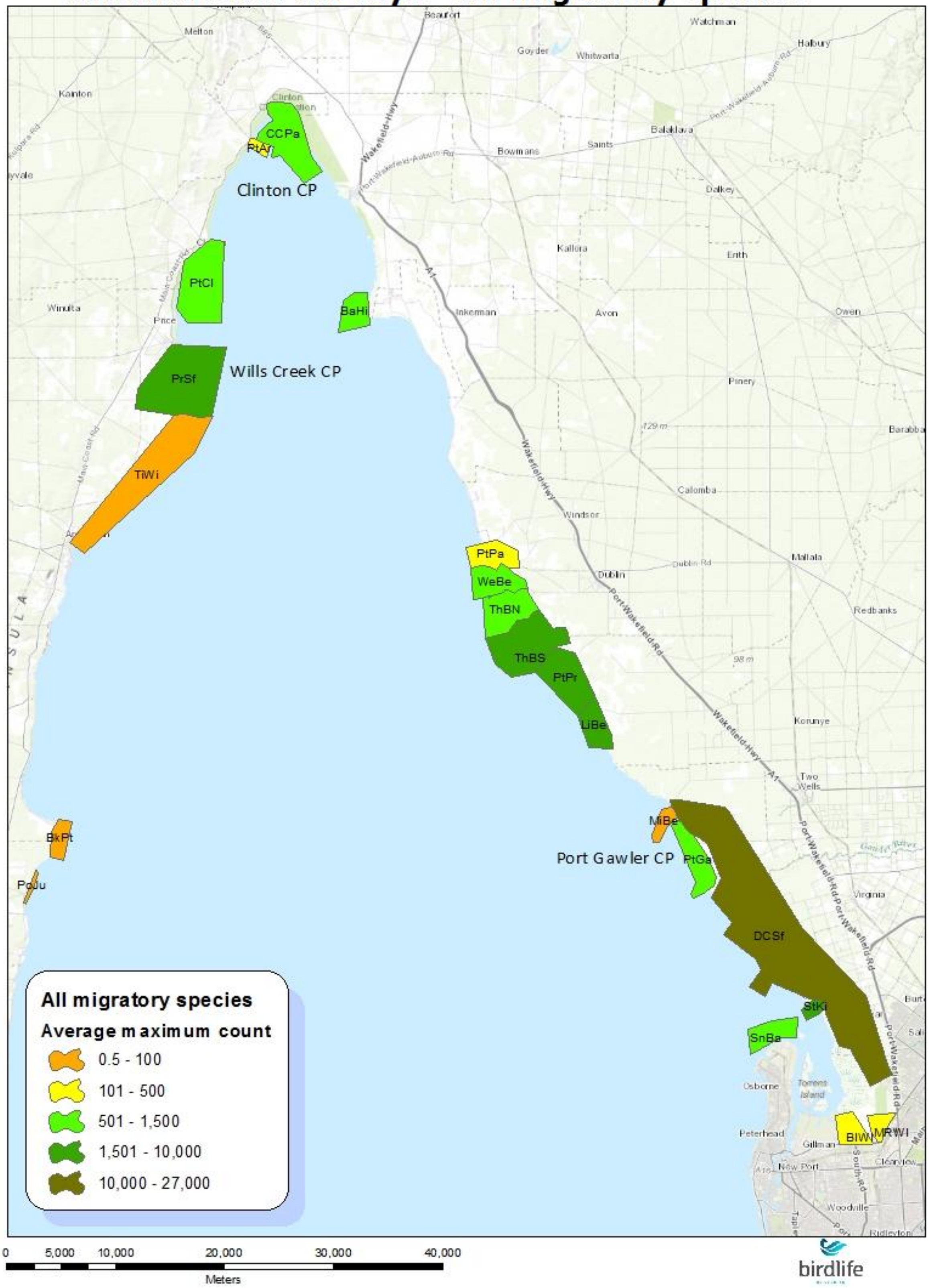
APPENDIX B: BirdLife Australia Birdata portal



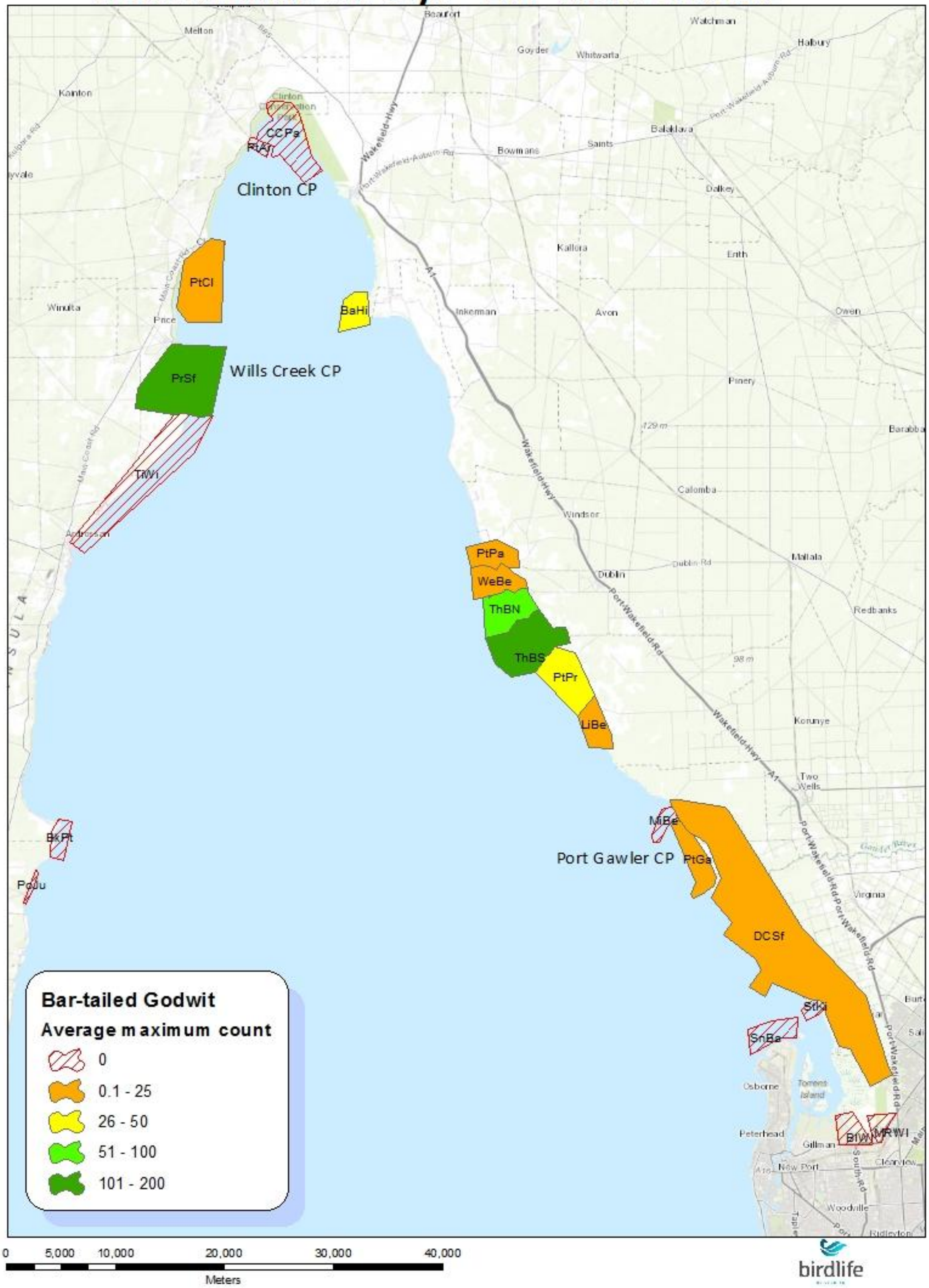


APPENDIX C: Average maximum counts of migratory species across the project period by site.

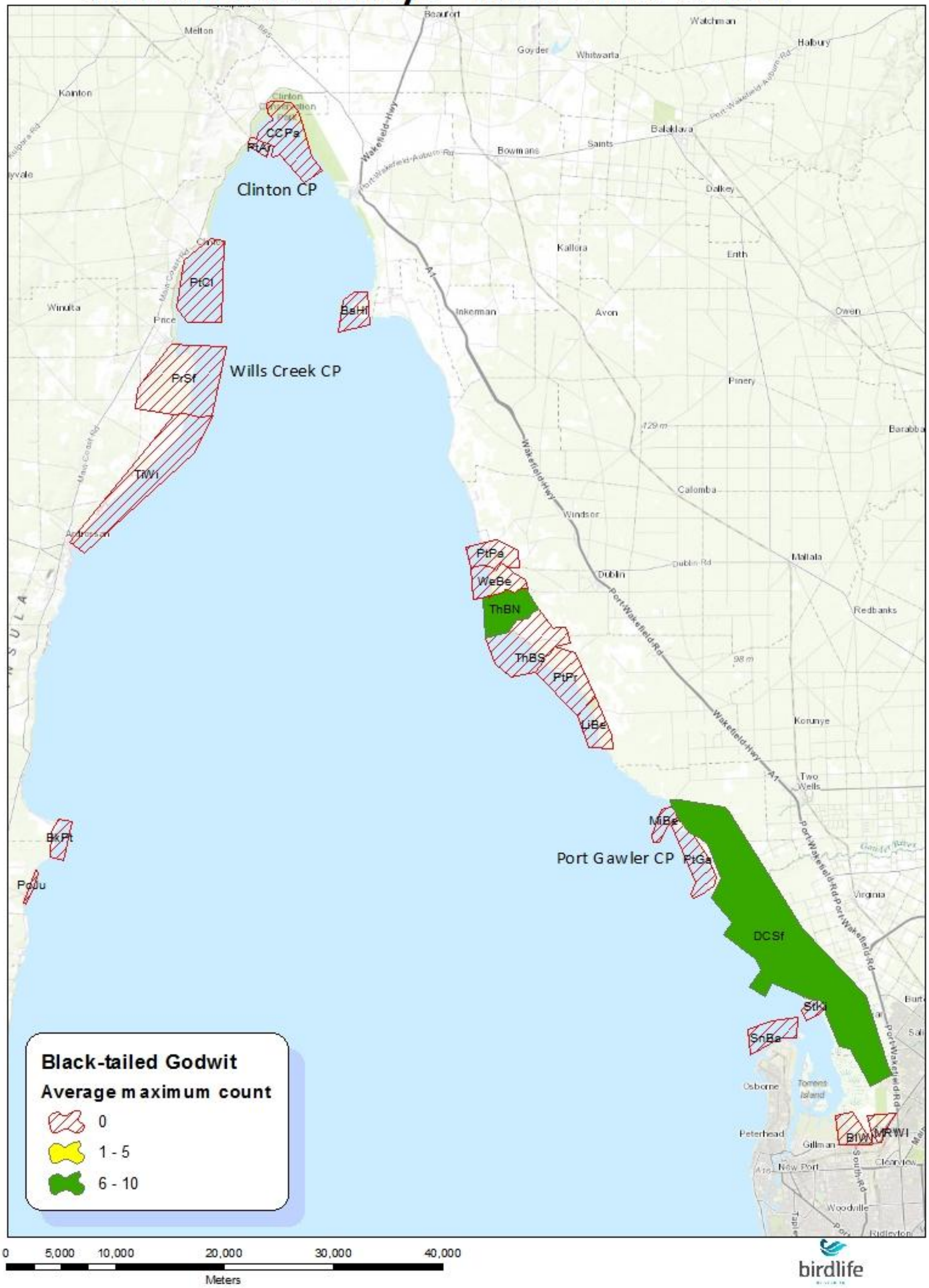
Average maximum counts from S2020 simultaneous surveys - All migratory species



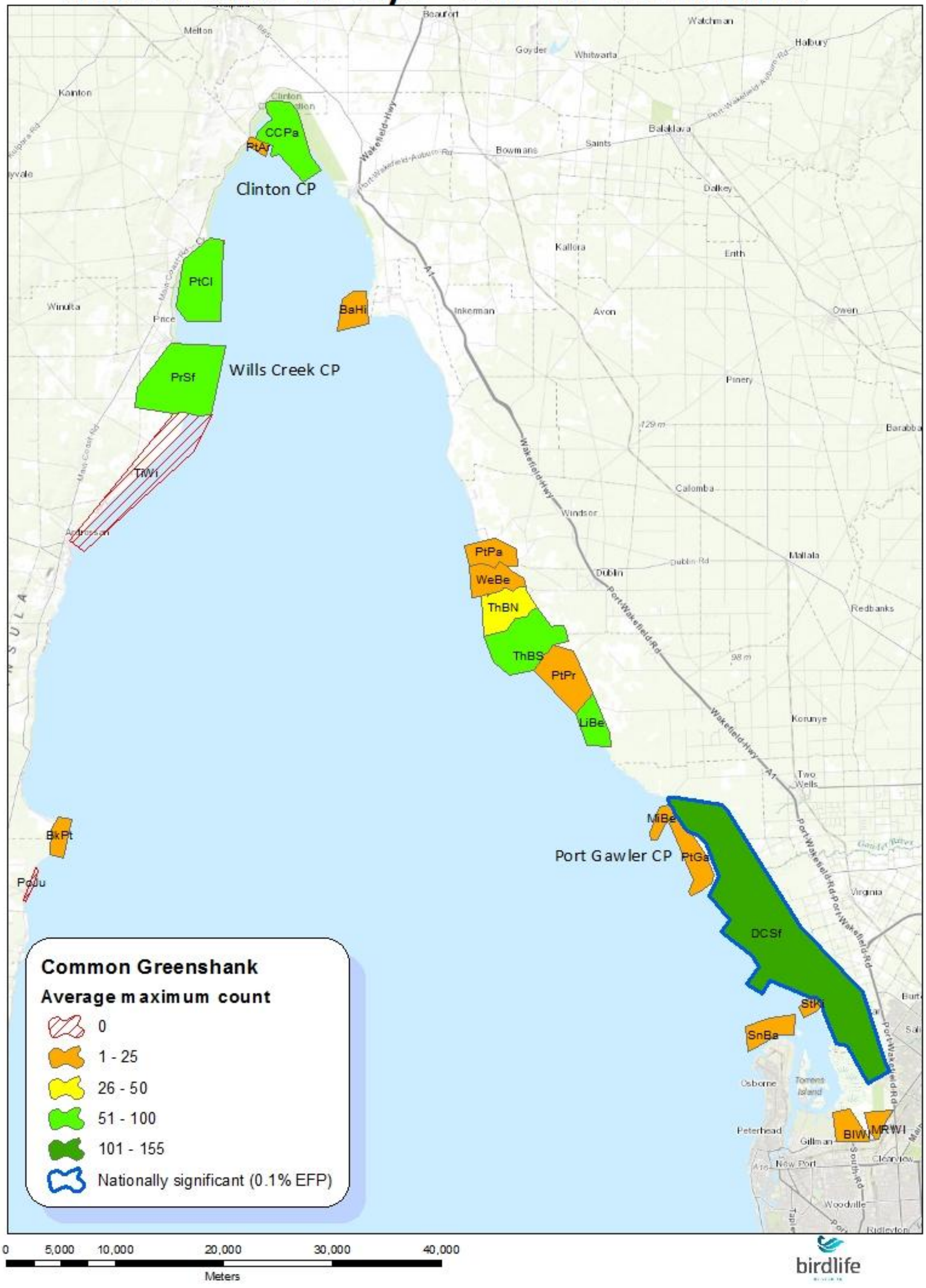
Average maximum counts from S2020 simultaneous surveys - Bar-tailed Godwit



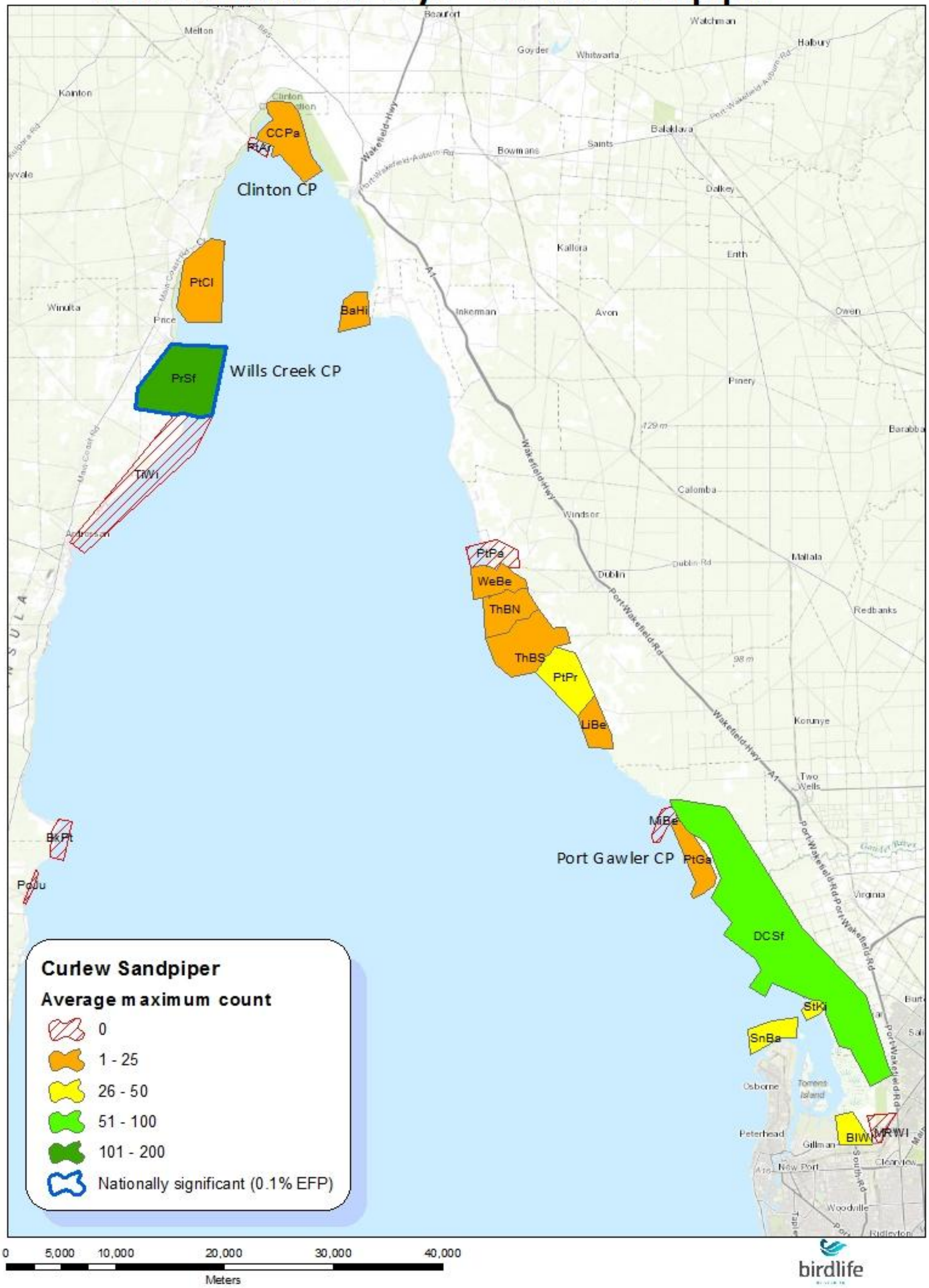
Average maximum counts from S2020 simultaneous surveys - Black-tailed Godwit



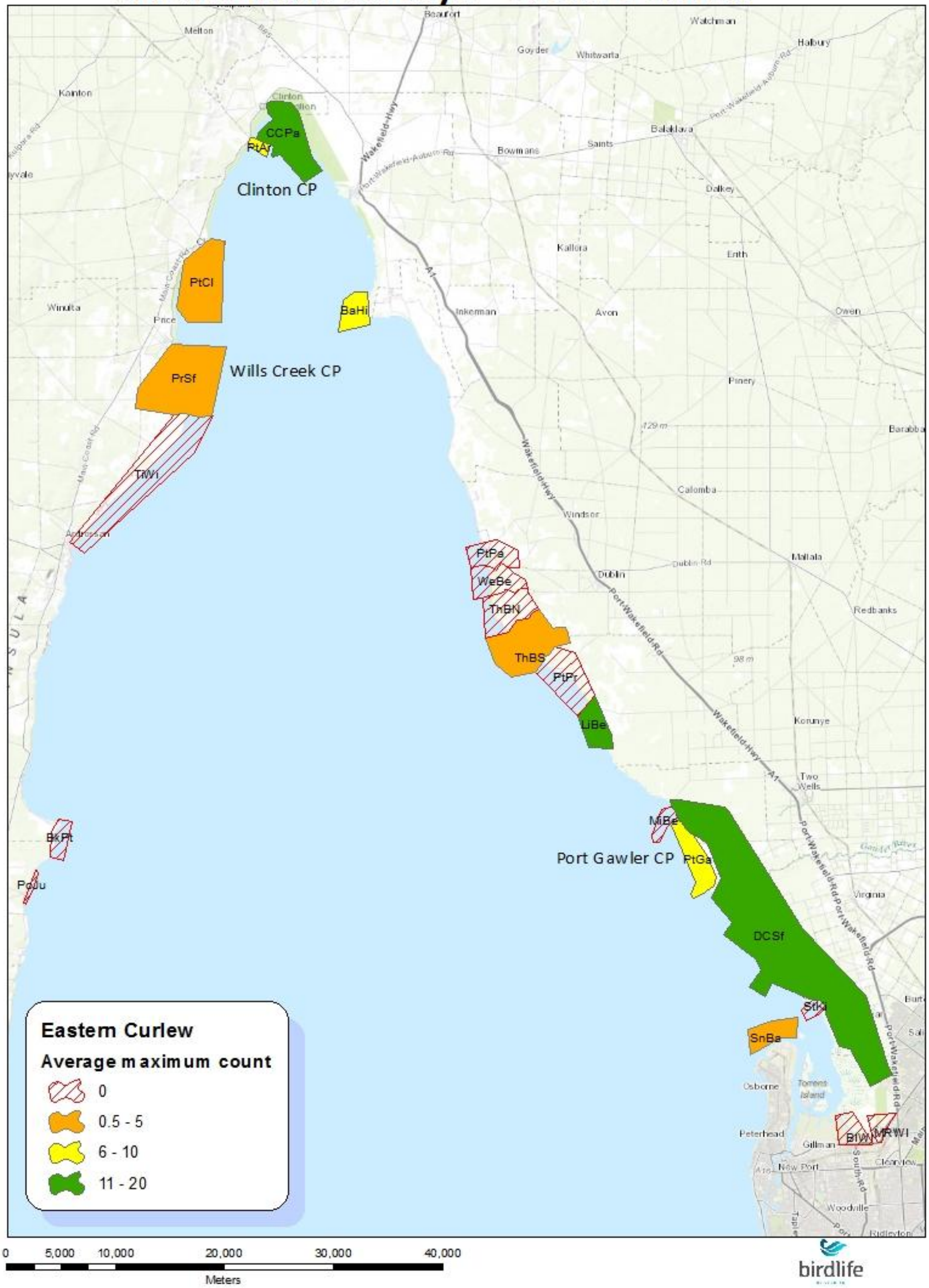
Average maximum counts from S2020 simultaneous surveys - Common Greenshank



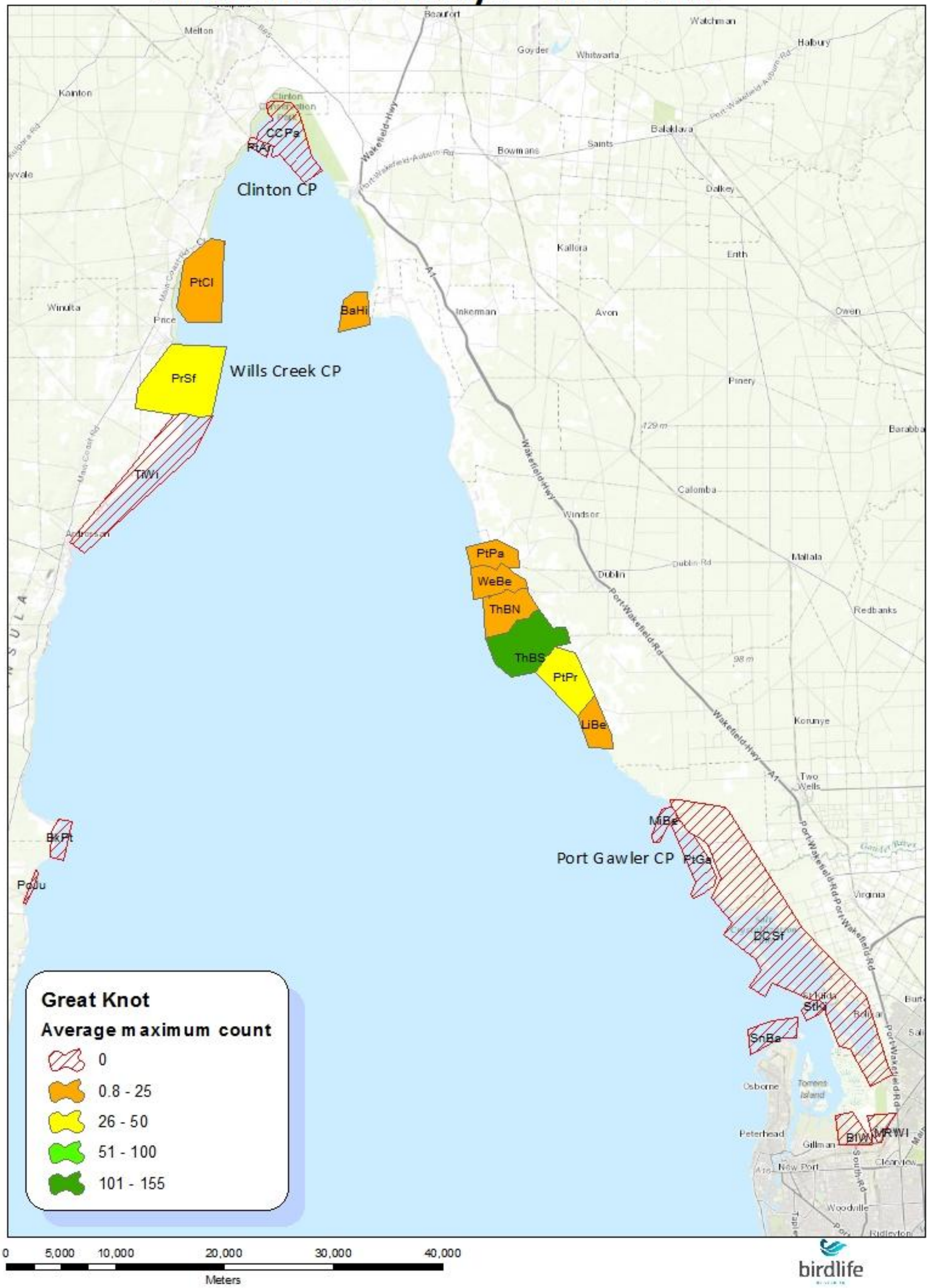
Average maximum counts from S2020 simultaneous surveys - Curlew Sandpiper



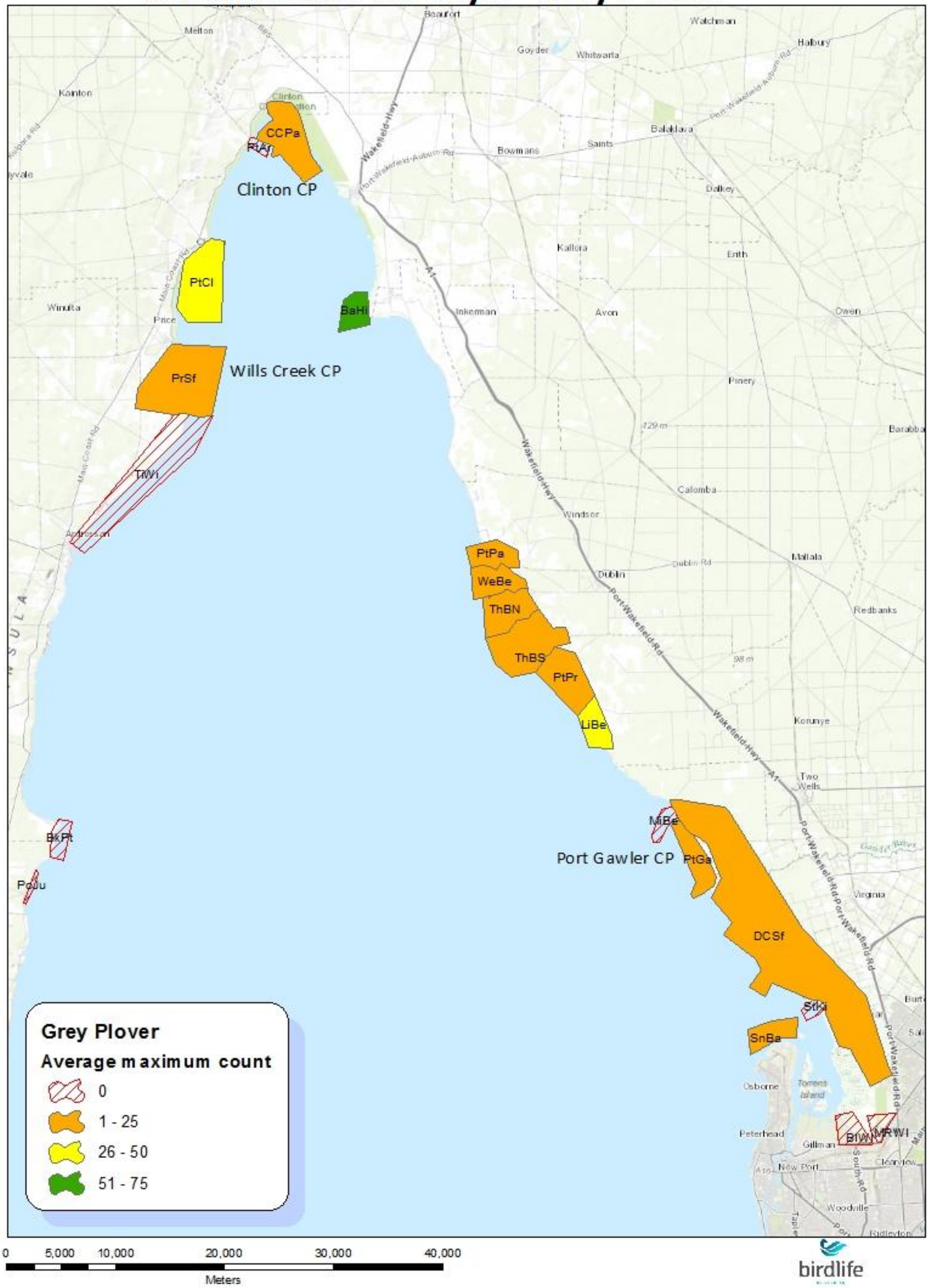
Average maximum counts from S2020 simultaneous surveys - Eastern Curlew



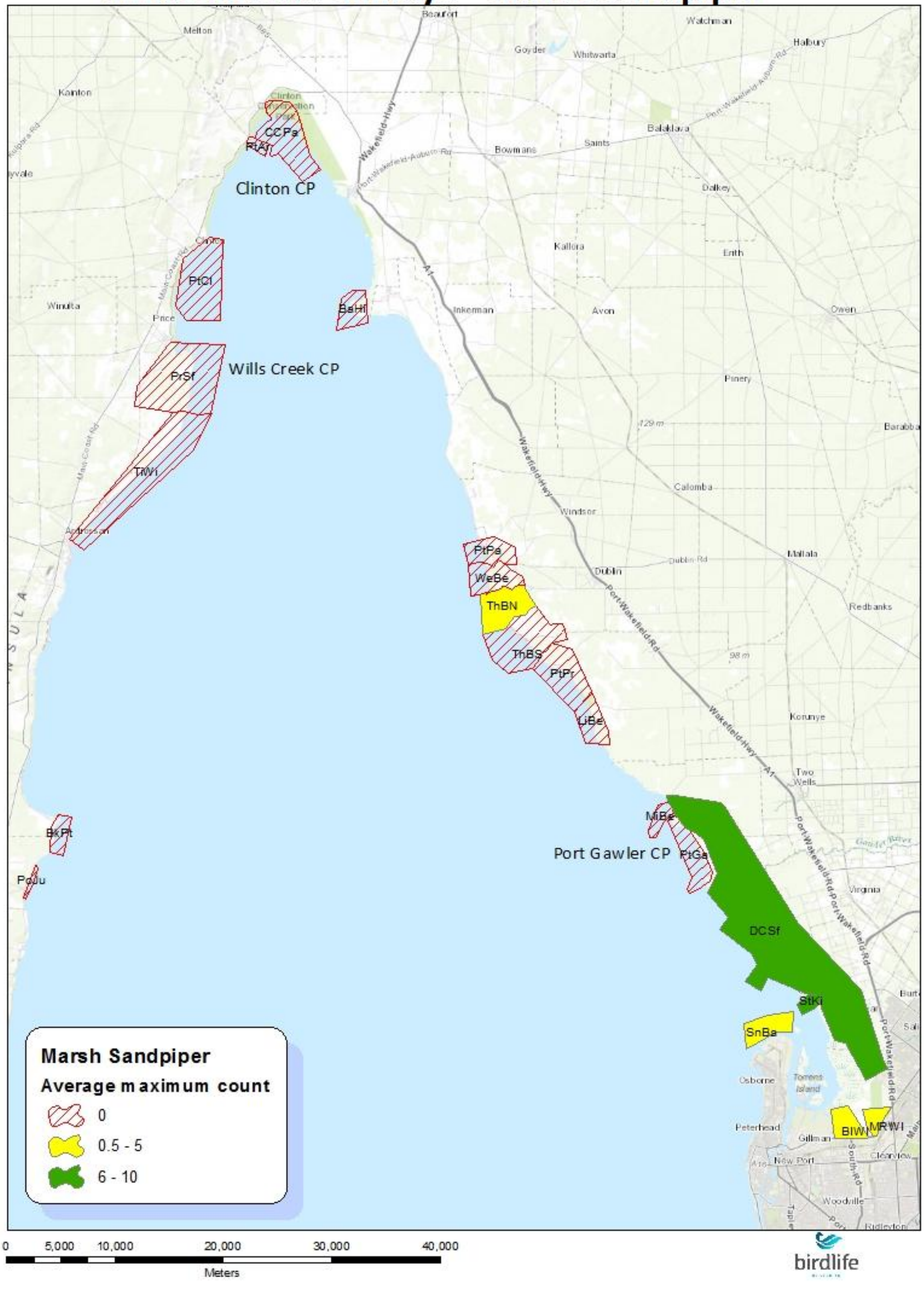
Average maximum counts from S2020 simultaneous surveys - Great Knot



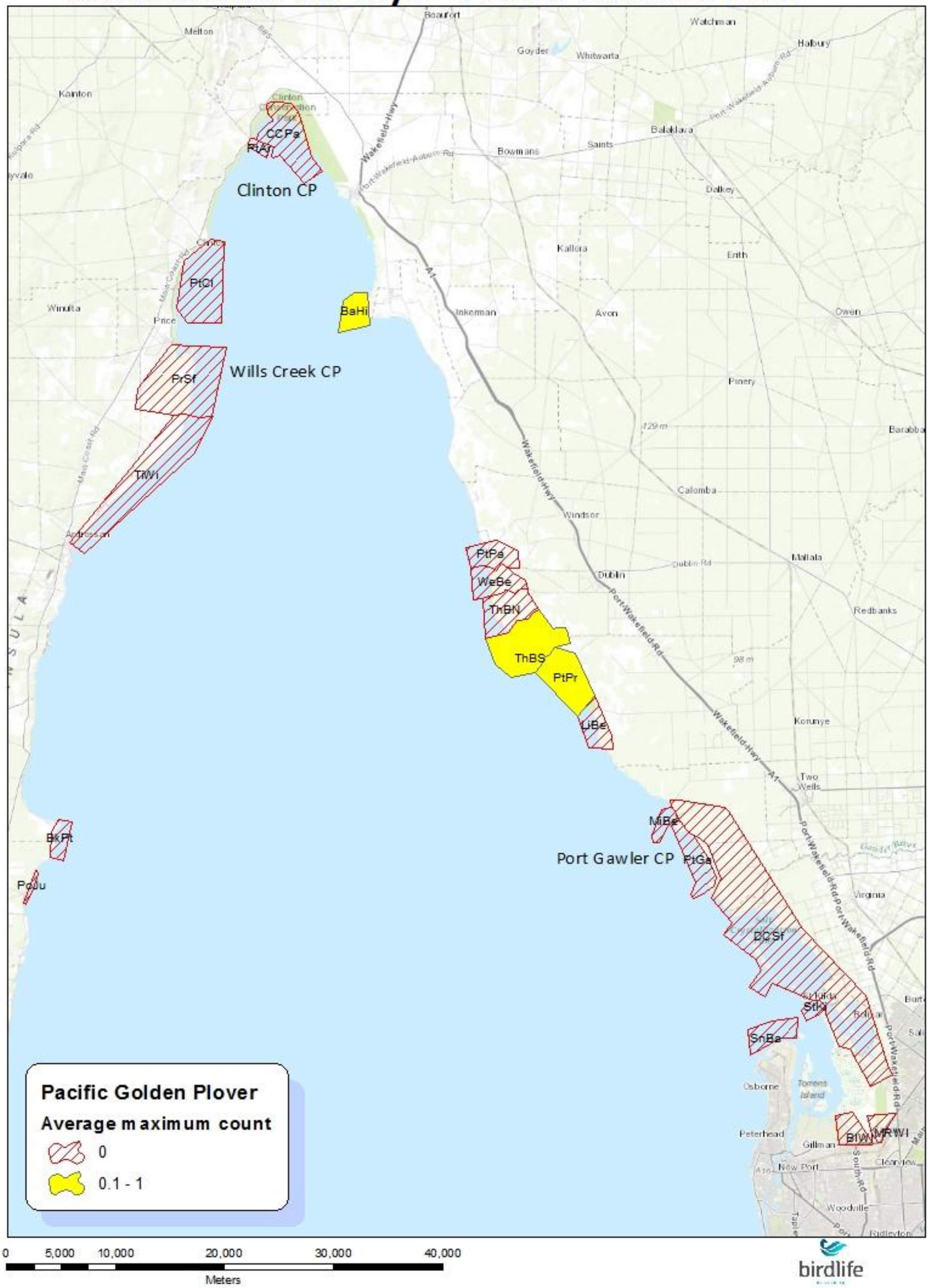
Average maximum counts from S2020 simultaneous surveys - Grey Plover



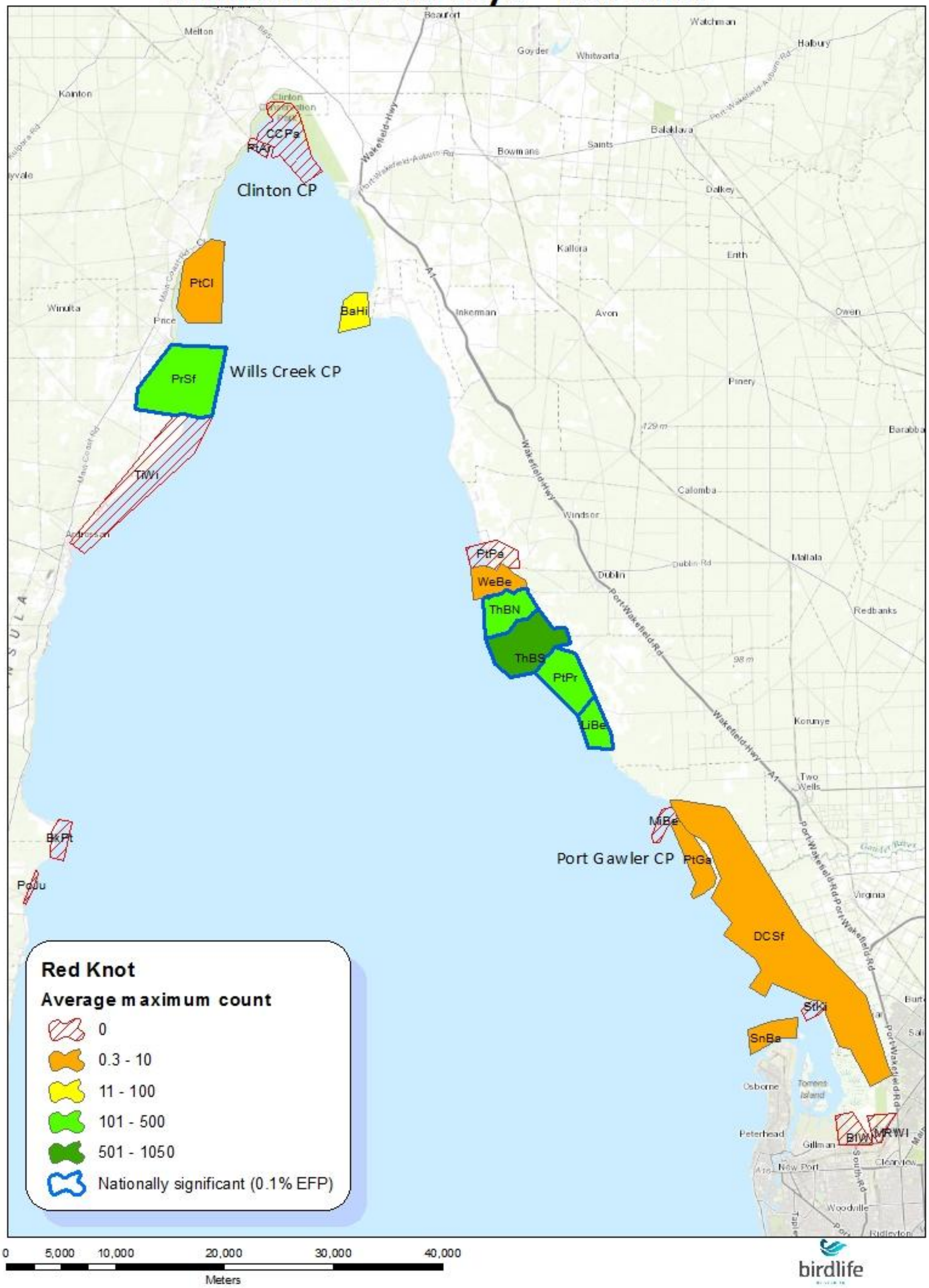
Average maximum counts from S2020 simultaneous surveys - Marsh Sandpiper



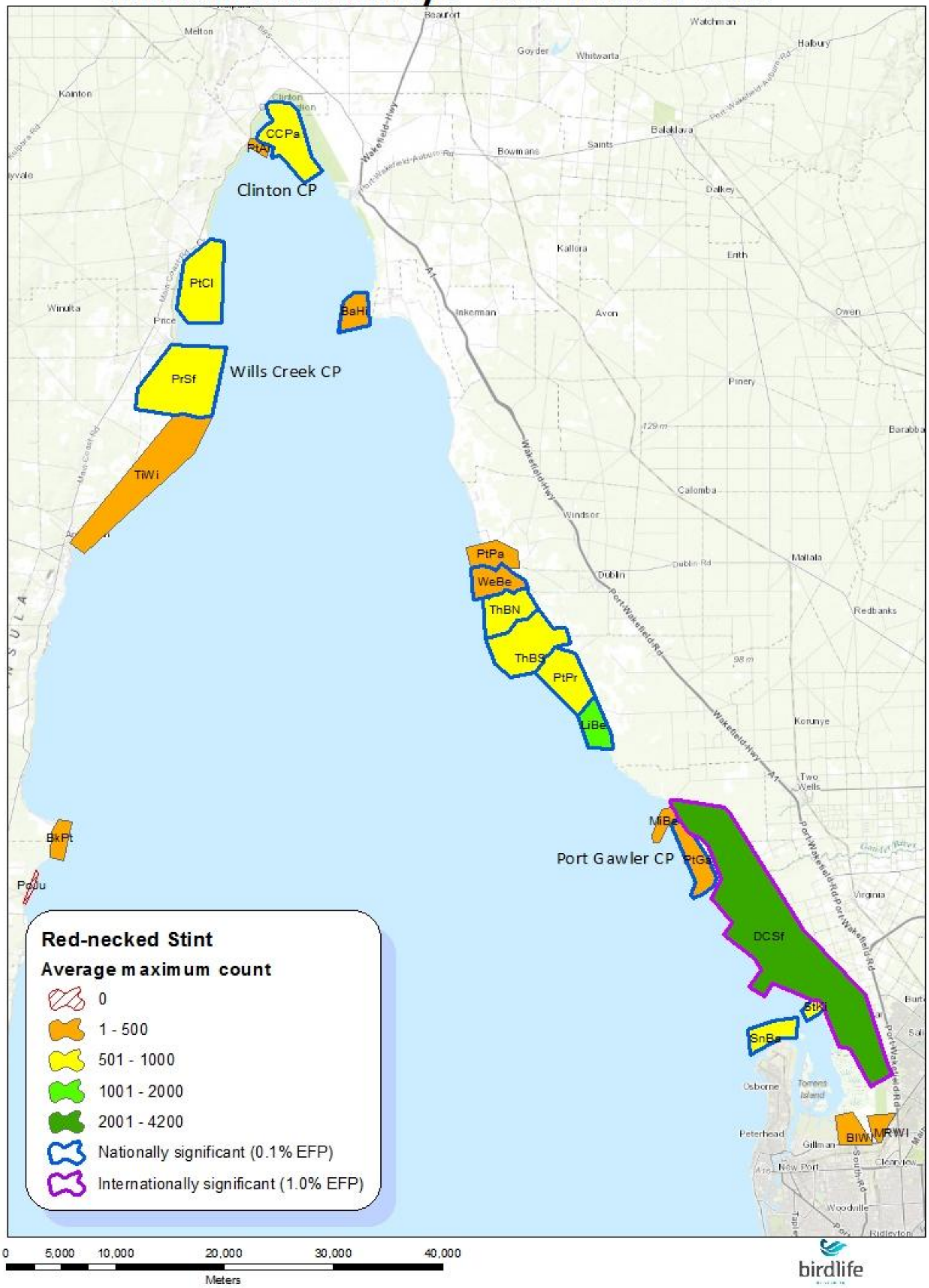
Average maximum counts from S2020 simultaneous surveys - Pacific Golden Plover



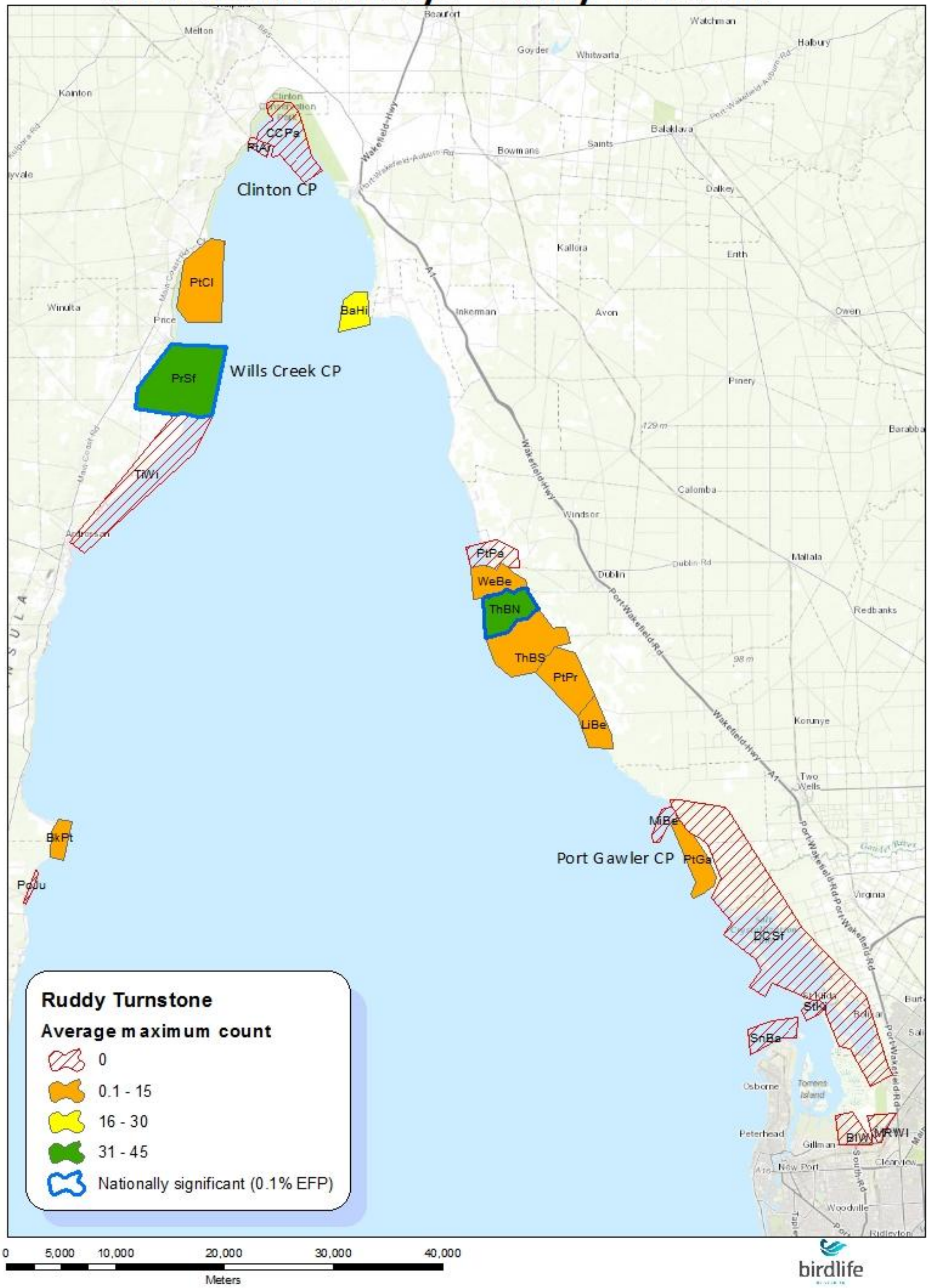
Average maximum counts from S2020 simultaneous surveys - Red Knot



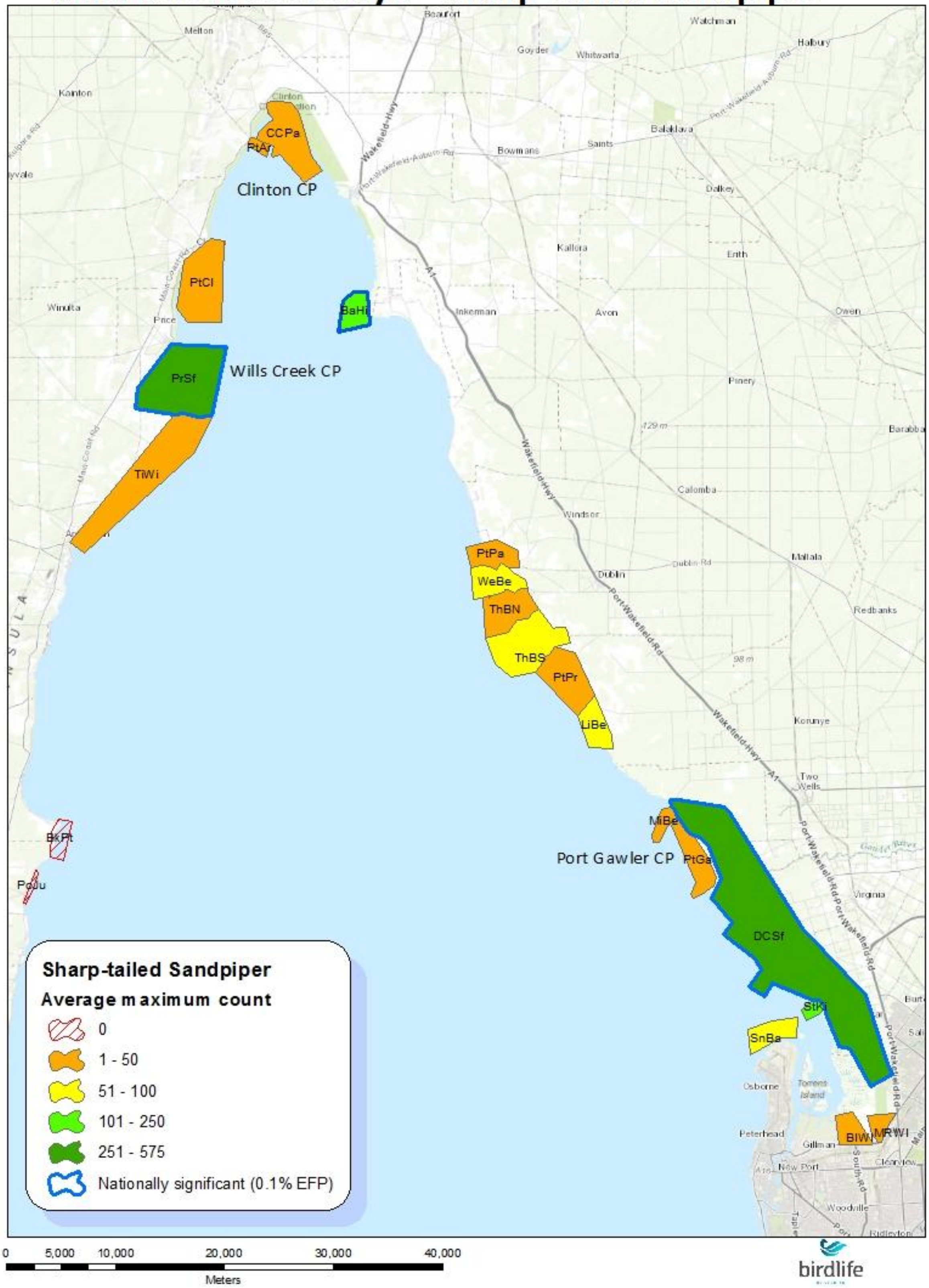
Average maximum counts from S2020 simultaneous surveys - Red-necked Stint

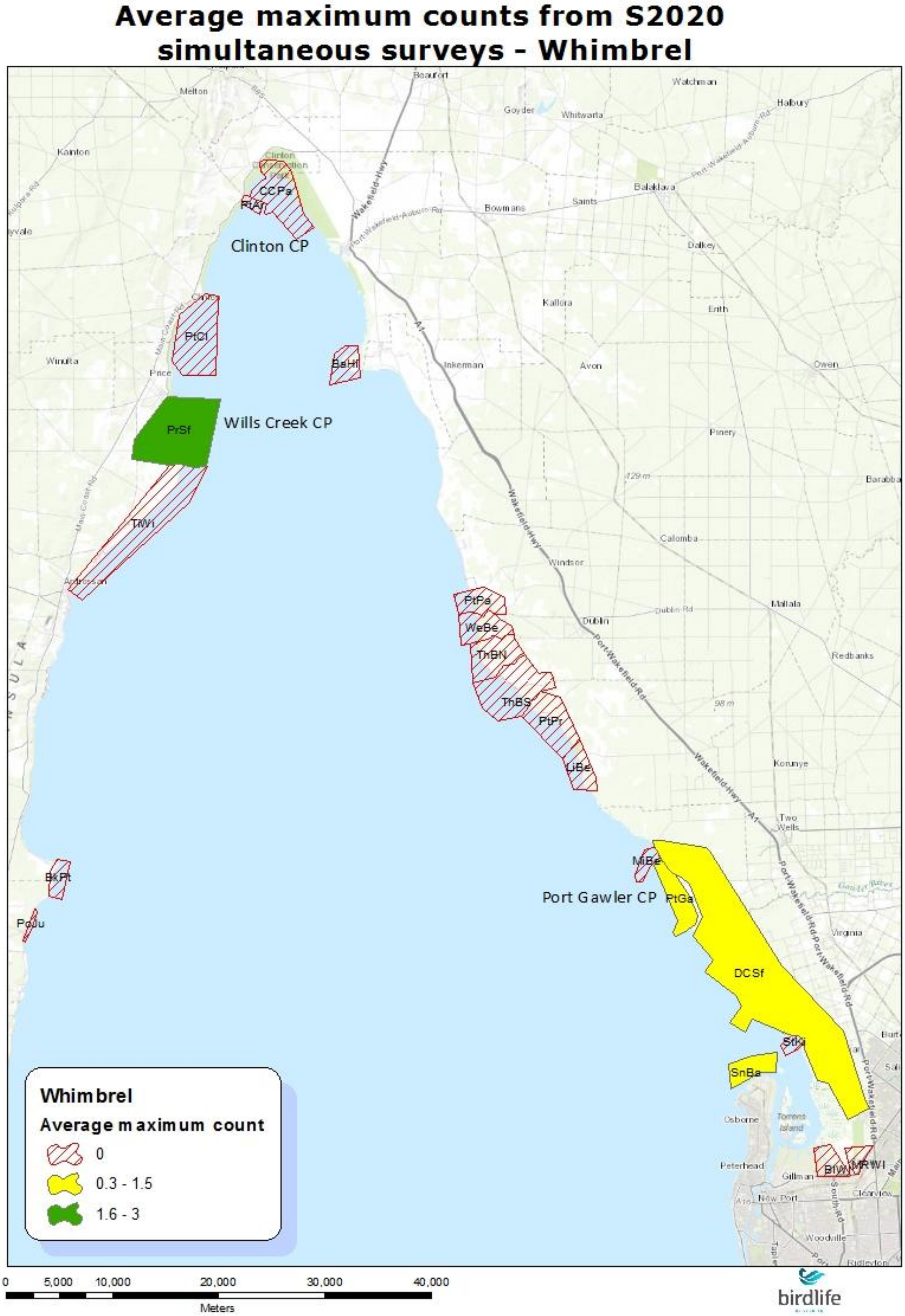


Average maximum counts from S2020 simultaneous surveys - Ruddy Turnstone



Average maximum counts from S2020 simultaneous surveys - Sharp-tailed Sandpiper




Average maximum counts from S2020
simultaneous surveys - Whimbrel
Clinton CP
CCPs
PtAr
PtCl
BsHl
Wills Creek CP
PrSf
TWI
PtPa
WeBe
ThBN
ThBS
PtPr
LiBe
MiBe
Port Gawler CP
PtGa
DCSf
StKi
SnBa
BIWI
MRWI
BkPt
PoJu
Whimbrel
Average maximum count
0
0.3 - 1.5
1.6 - 3
0
5,000
10,000
20,000
30,000
40,000
Meters
birdlife