Shorebird Monitoring and Habitat Mapping Project: Gulf St Vincent

Birds Australia

Australian Government

Government of South Australia

Adelaide and Mount Lofty Ranges Natural Resources Management Board

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EXECUTIVE SUMMARY

Shorebirds (also known as "waders") appear to be declining throughout the world, and their long-term survival will require the identification and protection of their habitat. The importance of migratory shorebird conservation has been recognised in several international conservation agreements that Australia has signed, as well as Australia's Environment Protection and Biodiversity Conservation Act 1999 which recognises migratory shorebirds as species of national significance. To achieve the protection of migratory shorebirds, managers and planners first need to be able to identify the areas that are important for shorebirds. This report: (a) describes two workshops conducted to raise awareness of the need for shorebird conservation and to recruit and train new counters; (b) describes the number of people involved and the methods used in the most complete known shorebird count ever conducted in Gulf St Vincent; (c) describes the methods and results of mapping important shorebird habitat in Gulf St Vincent (maps and attributes of shorebird areas are provided in the appendices); and (d) provides management-relevant information on shorebirds and the threats they face in Gulf St Vincent with additional references on where to get further information.

Gulf St Vincent supports internationally significant numbers of migratory shorebirds, which feed and roost on its extensive mudflats, sandy beaches, salt-marshes and commercial saltfields. The needs of resident shorebirds are met by habitats both along the sandy coastline and within associated environments.

The results of this summers workshops, monitoring, habitat mapping and information review reached out to 110 potential counters, 28 of which were known to have taken part in a count. As a result, 32 discrete count areas that provide important habitat for shorebirds in Gulf St Vincent were identified, including two with high shorebird abundance that had never been surveyed before. The only areas identified as highly threatened in the region were Port Prime, a beach where high visitation is likely to cause reduced breeding success, wader feeding and roosting; and St Kilda and the Cooboowie Inlet, two areas highly threatened by human-induced habitat loss. An additional 17 areas were identified as holding either migratory or resident shorebirds under moderate threat from disturbance, pollution, invasive species and the like. Additional threats were believed to be relatively low for the remaining shorebird areas; however, the habitats hold significant numbers of shorebirds will need to continue to be protected completely if shorebird populations are to be maintained in Gulf St Vincent.

We commend current councils and land managers for the progressive steps they have already taken to protect shorebirds in Gulf St Vincent. This report describes the shorebird surveys conducted in Gulf St Vincent in the summer of 2008–2009, and our efforts to recruit and train new counters. The report also identifies shorebird habitat in more detail than has been done previously so that it can be considered specifically in planning and management activities. Further, it is hoped that a review of potential local threats to shorebirds, together with sources for further information, will be useful for the protection of the shorebirds which inhabit Gulf St Vincent.

INTRODUCTION

Gulf St Vincent is the second most important area for shorebirds in South Australia behind the Coorong. The Gulf is bordered by shallow waters and fringed by extensive mudflats, mangroves, sandy beaches and saltmarsh. The area regularly supports an estimated 27 000 shorebirds with 12 species occurring in internationally significant numbers (Close 2008). This includes 10% of the world population of Sharp-tailed Sandpipers, 4% of Red-capped Plovers and 3% of the Sooty Oystercatcher population (Jensen 2004). There are also reports of over 30 000 Banded Stilts and 1300 Banded Lapwings (Watkins 1993). Despite meeting the criteria for inclusion as a Ramsar site, Gulf St Vincent has not been listed under the Ramsar Convention. The Gulf would also qualify for inclusion in the East Asian–Australasian Flyway site network.

Since 1985 there have been few organised counts of the Gulf (Close 2008). Some implications of incomplete or irregular counting are highlighted by Gosbell and Clemens (2007). Regular and rigorous counts are required to document species population trends with confidence, and are also required to provide sufficient information to administer the EPBC Act, or to ensure compliance with international agreements. Within Gulf St Vincent, more work is needed to ensure that counts are comprehensive and sufficiently consistent to allow them to contribute to national population monitoring of shorebirds and to increase the chances of detecting population trends within the Gulf. For these reasons, objectives were formulated to focus on increasing awareness of shorebirds, and consequently increasing the number of qualified counters and organised counts in Gulf St Vincent.

The population of shorebirds inhabiting the Gulf are considered to be independent of shorebirds that occur in other areas during the summer. However, movement of shorebirds within the Gulf can result in variable counts in any particular count area. For this reason, simultaneous counts are needed across known count areas within the Gulf to help eliminate double counts or missed birds. An increase in the number of qualified counters and in simultaneously surveyed count areas will mean regular Gulf-wide counts are more accurate and more comparable among years.

Shorebirds require habitat for roosting and feeding, but most shorebird surveys are conducted at roosting locations. The main reason for this is that at low tide shorebirds are too widely dispersed across large, inaccessible areas to survey easily. Fortunately, high-tide surveys allow results from repeat surveys to be compared, as shorebirds often use the same roosts throughout the year, and often use the same areas in subsequent years (Rehfisch *et al*. 1996; Peters *et al.* 2007; Pearce-Higgins 2001). In some areas shorebirds have occupied roosts so regularly that changes in the number of birds using them have been used to evaluate the effects of conservation measures and human disturbance (Burton *et al*. 1996). However, in Gulf St Vincent, shorebirds are often thought to use a variety of spread-out roost sites.

Documented worldwide declines in shorebird populations highlight the need to recognise and conserve the internationally important shorebird habitat that exists in Gulf St Vincent. It is critical to minimise the threats to shorebirds and their habitat both within and outside protected areas in the Gulf to sustain shorebird populations

There is a clear need for making information available to ensure that planners and managers in the area understand how to avoid adverse impacts on these important habitats. In addition, the need for conservation of shorebirds and their habitats is growing as shorebird populations are declining throughout the world, and an increasing number of governments are initiating conservation agreements and legal conservation measures.

This report describes efforts to recruit and train volunteer counters, and outlines both the 2008/09 summer counts and the level of effort required to conduct future counts. It also highlights gaps in our knowledge about shorebirds and their habitats in the Gulf. The report maps the known distribution and extent of shorebird habitat in Gulf St Vincent, and summarises information which is valuable in providing support for planning and management to minimise impacts on shorebird habitat.

What are shorebirds?

Shorebirds (also known as "waders") in Gulf St Vincent include sandpipers, plovers, stints, oystercatchers, godwits, curlews, knots and greenshanks. All shorebirds are characterised by their long bills, used for foraging in wetlands, and long legs and toes which are useful for wading in soft sediment. In Australia, shorebirds are categorised as either migratory or resident. Migratory shorebirds spend the non-breeding season in Australia, having flown up to 13 000 kilometres from their breeding grounds; resident shorebirds breed in Australia and remain here throughout the year (Clemens *et al*. 2007).

Figure 1. Banded Stilt congregate in great numbers to feed and roost in the waters and saltfields of Gulf St Vincent. Photo by Glenn Ehmke

Global shorebird population trends

Throughout the world many shorebird populations appear to be declining (Morrison *et al*. 2000, 2001; Wilson 2000; IWSG 2003; Olsen *et al*. 2003; CHASM 2004; van de Kam *et al*. 2004). In 2003, trend estimates were available for 41% of the 499 shorebird populations around the world; of these, 44% appear to be decreasing, 13% increasing, 39% are stable and 4% are extinct (Wetlands International 2002; Delaney 2003; IWSG 2003). The population declines detected coincide with accelerating loss

and degradation of shorebird habitat (UNEP 2006). In the East Asian–Australasian Flyway, a disproportionately high number of shorebird species have been classified as threatened, and are under increasing threat from habitat destruction (IWSG 2003; Minton *et al*. 2003). Of the Australian resident species, Hooded Plover populations appear to be declining mainly due to human disturbance during nesting, and degradation of habitat (Weston 2003).

Global 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 Asia-Australasia Shorebird Reserve Network. Additionally, there are 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). Australia's Environment Protection and Biodiversity Conservation Act 1999 also recognises the importance of migratory shorebird conservation, treating these birds as being of national environmental significance (Clemens *et al*. 2007). All of these agreements require the identification and protection of areas for conservation; the species that these areas aim to conserve are outlined in Table 1.

Shorebird needs in Gulf St Vincent

Shorebird habitat in Gulf St Vincent provides for a diverse range of needs for shorebird survival and reproduction. All shorebird habitats must provide the energy needed for survival by providing a combination of feeding areas rich in food, and nearby roosting areas that allow shorebirds to rest without loosing too much energy to disturbance. Further, shorebird habitat must minimise the risk of mortality by providing sufficiently open areas to allow shorebirds to detect and avoid predation. Finally, for resident shorebirds the wetlands surrounding the Gulf must provide habitat sufficient to allow for successful breeding. Before these important components of shorebird habitat can be conserved they mush first be well identified

Table 1. Shorebird species regularly found in Gulf St Vincent, their status, and national and international thresholds (Bamford *et al*. 2008).

Common Name	Scientific Name	EPCA Act	FFG Act	NPWA	CAMBA	JAMBA	ROKAMBA	BONN	EAA 0.1%
Banded Lapwing	*Vanellus tricolor*								
Banded Stilt	*Cladorhynchus leucocephalus*								
Bar-tailed Godwit	*Limosa lapponica*	Migratory/Marine		Rare	Listed	Listed	Listed	Listed	325
Black-Fronted Dotterel	*Elseyornis melanops*								
Black-tailed Godwit	*Limosa limosa*	Migratory/Marine		Rare	Listed	Listed	Listed	Listed	160
Black-winged Stilt	*Himantopus himantopus*								
Common Greenshank	*Tringa nebularia*	Migratory/ Marine			Listed	Listed	Listed	Listed	60
Common Sandpiper	*Actitis hypoleucos*	Migratory/ Marine		Rare	Listed			Listed	100
Curlew Sandpiper	*Calidris ferruginea*	Migratory// Marine			Listed	Listed	Listed	Listed	180
Double-banded Plover	*Charadrius bicinctus*	Migratory/Marine			Listed	Listed		Listed	38
Eastern Curlew	*Numenius madagascariensis*	Migratory/Marine		Vulnerable	Listed	Listed	Listed	Listed	38
Great Knot	*Calidris tenuirostris*	Migratory/Marine	Listed	Rare	Listed	Listed	Listed	Listed	375
Greater Sand Plover	*Charadrius leschenaultii*	Migratory/Marine		Rare	Listed	Listed	Listed	Listed	110
Grey Plover	*Pluvialis squatarola*	Migratory/Marine		Rare	Listed	Listed	Listed	Listed	125
Grey-tailed Tattler	*Tringa brevipes*	Migratory/Marine	Listed	Rare	Listed	Listed		Listed	50
Hooded Plover	*Thinornis rubricollis*	Marine	Listed	Vulnerable					
Lesser Sand Plover	*Charadrius mongolus*	Migratory/ Marine			Listed	Listed	Listed	Listed	140
Marsh Sandpiper	*Tringa stagnatilis*	Migratory/Marine			Listed	Listed	Listed	Listed	1000
Masked Lapwing	*Vanellus miles*								
Pacific Golden Plover	*Pluvialis fulva*	Migratory/ Marine		Rare	Listed	Listed	Listed	Listed	100
Pectoral Sandpiper	*Calidris melanotos*	Migratory/ Marine		Rare		Listed	Listed	Listed	10
Australian Pied Oystercatcher	*Haematopus longirostris*								
Red-capped Plover	*Charadrius ruficapillus*								
Red-necked Avocet	*Recurvirostra novaehollandiae*								
Red-kneed Dotterel	*Erythrogonys cinctus*								
Red Knot	*Calidris canutus*	Migratory/Marine			Listed	Listed	Listed	Listed	
Red-necked Stint	*Calidris ruficollis*	Migratory/Marine			Listed	Listed	Listed	Listed	325
Ruddy Turnstone	*Arenaria interpres*	Migratory/Marine		Rare	Listed	Listed	Listed	Listed	35
Sharp-tailed Sandpiper	*Calidris acuminate*	Migratory/ Marine			Listed	Listed	Listed	Listed	160
Sooty Oystercatcher	*Haematopus fuliginosus*			Rare					
Terek Sandpiper	*Xenus cinereus*	Migratory/Marine	Listed	Rare	Listed	Listed	Listed	Listed	60
Whimbrel	*Numenius phaeopus*	Migratory/ Marine		Rare	Listed	Listed	Listed	Listed	100
Wood Sandpiper	*Tringa glareola*	Migratory/Marine		Rare	Listed	Listed		Listed	10

EPBCA: Environment Protection and Biodiversity Conservation Act 1999

CAMBA: China–Australia Migratory Bird Agreement

FFG Act: Flora and Fauna Guarantee Act 1988

JAMBA: Japan–Australia Migratory Bird Agreement (JAMBA)

Bonn: Convention on the Conservation of Migratory Species of Wild Animals (Bonn Convention)

NPWA:National Parks and Wildlife Act 1972

EEA: East Asian–Australasian Flyway

Conservation status of shorebird areas in Gulf St Vincent

Most of the important shorebird sites in Gulf St Vincent are legally protected within the reserve system administered by the National Parks and Wildlife Service, or occur within protected Australian Defence Force land or commercial saltfields (Map 1). The only strictly 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 and the coast and islands which lie within the Upper Gulf St Vincent and the Lower Yorke Peninsula Marine Parks.

Clinton Conservation Park is situated at the northern end of the Gulf. It is over 18.54 km² and supports mangroves, associated tidal flats, samphire and chenopod shrublands. It is the largest reserve in the Gulf, and one of the most significant sites in terms of shorebirds (Close & McCrie 1986; Watkins 1993). Large areas under salt harvesting leases from the State government provide havens for shorebirds: on the east coast at Dry Creek Saltfields; and on the west coast at Price Saltfields.

Figure 2. Populations of Red-necked Avocet continue to decline across SE Australia.

The coastline between Clinton Conservation Park and 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 scattered small coastal townships and areas of agricultural land. These developed areas are interrupted by an undeveloped 18.5-kilometre stretch of coast extending from north of Port Parham to south of Port Wakefield, reserved for the Australian Defence Force Proof and Experimental Range. This area has a public exclusion zone which extends beyond the tidal flats into the waters of the Gulf. Much of the Samphire Coast's intertidal flats fall under the protection of the Upper Gulf St Vincent Marine Park, which encompasses 971 km². The park includes the coast up to the median tide line and waters of the Gulf north of a line joining Parara Point in the west and the northern end of Port Gawler Beach. Similarly, 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 Marine Park, provides feeding and roosting sites for a large number of shorebirds.

Adjacent areas include private land and foreshore reserves which receive varying levels of protection, mainly from vehicle degradation of dune environment (Fig. 5). The potential impacts to important shorebird areas are greatest in these non-protected areas, but if viable populations of shorebirds are to be maintained, protected areas and the threats from adjacent areas that can impact shorebird habitat must be managed carefully.

Threats to shorebirds in Gulf St Vincent

The threats to shorebird populations and their habitats in Gulf St Vincent include human-induced habitat loss or degradation, human disturbance, invasive species, pollution and human-induced mortality or breeding failure. The severity 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 wader numbers may be also be attributed largely to factors independent of the Gulf (Close 2008). These conclusions are based on a 50% decline (from 59 851 to 29 929) in numbers of northernhemisphere (or Palaearctic) breeding species recorded in the Gulf between 1979 and 2008. In contrast, resident species declined overall by only 12%. However, within the category of residents, the number of Red-necked Avocets declined by 96%, and numbers of Black-winged Stilts, Red-kneed Dotterels, Red-capped Plovers and Masked 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 2007), and recommends that threats to local shorebird habits need to be identified.

The potential for development along the Gulf's coast introduces all of the above-mentioned threats to the stability of shorebird habitats and creates irreversible flow-on effects. For example, in recent years, 1,000,000 m^3 of sand has been artificially deposited in developed coastal areas around Adelaide to combat a deficiency in the natural deposition processes that normally replenish the beaches (DEH 2005). This, combined with the threat of rising sea levels due to global warming, could result in a coastal squeeze on beaches, mudflats and sandflats. Even a slight increase in sea level or increase in severe weather conditions would greatly reduce the available area of shorebird habitat, causing displacement of beach-roosting and beach-nesting birds, while also intensifying the impacts of beach recreation on their breeding success (Hamilton & Ingwersen 2007).

Figure 3. Sand is artificially deposited on metropolitan beaches to combat the norhtern drift of sediment.

Examples of the impact coastal development can have on shorebird communities has been observed at St Kilda, where the reclamation of mudflats has degraded feeding and roosting sites (Coleman & Cook 2003) and at urban beaches such as Aldinga Beach. The urbanised stretch of coast south of Adelaide has historically supported a healthy number of shorebirds, including breeding Hooded Plovers, However, since extensive development and increasingly intensive use by people, wader numbers have plummeted (Close 2008) and Hooded Plovers have become increasingly rare (Aldinga Beach Coast Care Group 2009, pers. comm.).

Coastal dunes and surrounding habitat are also under threat from environmental weeds. Marram Grass *Ammophila arenaria*, Sea Spurge *Euphorbia paralias*, African Boxthorn *Lycium ferrocissimum* and Tree Mallow *Lavatera arborea* are hardy opportunistic colonisers which threaten to choke shorebird habitat. Ironically, Marram Grass was introduced from Europe over a century ago to stabilise mobile sand dunes. It has successfully colonised areas of open substrate throughout the Gulf, displacing 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 terrace dunes are preferred by resident shorebirds such as Hooded Plovers and Red-capped Plovers, as are sparse native grasses which provide incubating birds 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 in shorebirds in that area.

Sea Spurge, a native of the Mediterranean coasts, occurs on free-draining sandy soils on beaches, around estuaries, on dune fields and in associated coastal habitats (Wilcock 1997). This species is widespread throughout the Gulf, especially north of Middle Beach (Coleman 2009, pers. comm.). Infestation by this plant may impact beach-nesting birds such as terns, Hooded Plovers and Red-capped Plovers elsewhere (Park 1994, Rudman 2003) and may result in steep dunes that are susceptible to wave erosion.

African Boxthorn and Tree Mallow are woody weeds that occur on chenier ridges and dunes. Although more confined to urban beaches, they threaten to proliferate along coasts throughout the Gulf and have already impacted areas surrounding Middle Beach, Thompson Beach and Buckland Park Lake. Infestations of these plants have blanketed bare sites favoured for nesting by terns on Section Banks, and have caused significant problems in coastal habitats elsewhere, including the displacement of nesting puffins (McKie 2005) and the loss of valuable shorebird areas, including Mud Islands in Victoria and West and Encounter Islands in South Australia (Veitch *et al*. 2002; Carpenter 2008). 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.

Some native plants also pose a threat to shorebird habitat in Gulf St Vincent, with incursion by mangrove 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 sea-level change and sediment supply. In some parts of the Gulf, areas vegetated with Grey Mangrove *Avicennia marina* are expanding at an unprecedented rate (Saintilan & Williams 2001; Harty 2009), as reflected by the number of young mangroves sprouting among the saltmarsh plants. This is especially prevalent in Barker Inlet, where 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 (Harty 2006). Shorebirds prefer the security of open spaces with high visibility for the easy detection of approaching predators by feeding and roosting birds (Straw *et al*. 2006). In a survey of 63 intertidal mudflats in nine estuaries in New South Wales, 90% of ground-roosting sites used by shorebirds were more than 10 m from 2-m high trees and shrubs, and 83% were at least 30 m from 5-m high trees (Lawler 1996), illustrating shorebirds' preference for open areas.

Locally nesting shorebirds are also under threat from expanding populations of opportunistic native animals. Silver Gulls actively prey upon young birds and eggs. Gull numbers have increased substantially in the Gulf over the last 50 years, following the increased availability of food at rubbish tips (Carpenter 2008). The negative impact that Gulls have on nesting shorebirds has, in the past, prompted active gull control (Baxter 2003). Changes to the management of Wingfield Rubbish Tip since 2005 have reduced the amount of food available to gulls, thus reducing their numbers and restricting their breeding opportunities, but, nevertheless, gulls still occur in enormous numbers around the Gulf.

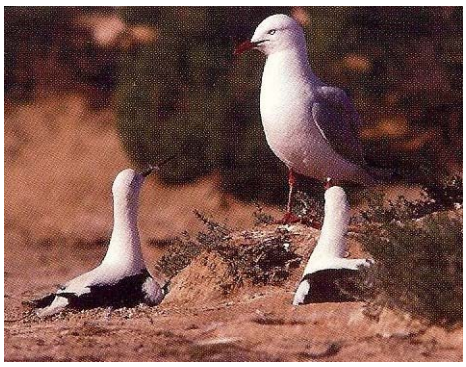

Figure 4. A Silver Gull waits for an opportunity to take an egg from nesting Banded Stilts.

The Integrated Waste Services (IWS) northern landfill site at Dublin provides another attraction for gulls. It has also been raised as a source of concern for members of the Foreshore Advisory Committee of the Malalla District Council regarding pollution. A proposal to dump potentially dangerous heavy metals and chemicals at the site poses the threat of seepage into the groundwater. Although the site is more than 4 km from the coast, there is still potential for pollutants to leach into the waters of the Gulf. The landfill site also borders on stretches of saltmarsh, including areas potentially used for high-tide roosts by shorebirds.

The upper sections of Gulf St Vincent provide important breeding and nursery areas for a number of key species, including King George Whiting and Blue Swimmer Crab, which are fished both recreationally and commercially. A steady increase in fishing is responsible for high levels of disturbance to shorebirds and destruction of habitat around the Gulf (Fitzpatrick et al 1998). In particular, a highly active crabbing community works the coast, especially during summer, when migratory shorebird populations are at their peak. 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. Fishermen also compete directly with shorebirds when collecting large amounts of benthic invertebrates for use as bait (Carpenter 2008).

Figure 5. Evidence of off-road vehicles likely to impact on shorebirds on Webb Beach, adjacent to a vehicle exclusion area.

Continuous stretches of sandy coastline allow recreational vehicle access to remote areas and unutilised fishing sites (Fig. 5), which disturbs roosting and feeding

shorebirds, potentially causing them to abandon their nests, and these vehicles sometimes hit shorebirds or crush their nests. The use of off-road vehicles also has an impact on macrobenthic assemblages on sandy beaches (Schlacher *et al*. 2007). The closure of the Port Gawler Off-road Vehicles Park in late 2006 has resulted in an increase in the number of off-road vehicles using potential shorebird habitat. In particular, dirt bike riders have been regularly gaining access to protected areas by flattening fences, thus not only destroying habitat but also creating disturbance at inland roosts (Frost, 2009, pers. comm.). Previous research into the use of four-wheel-drives in shorebird areas show that only a small proportion (15%) of off-road drivers heed signs asking them to avoid sensitive shorebird areas (McGrath 2006). This problem has escalated due to the increasing affordability and accessibility of off-road vehicles.

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 are threatened by human-induced breeding failure or mortality, and other pressures such as predation by foxes (Dowling 1999; Weston 2000). Preventable sources of breeding failure or mortality arise from people, vehicles or dogs on the beach (Fig. 6). All of which can accidentally crush eggs or young, disturb birds to the point that they are unable to incubate eggs to maintain a suitable temperature or to brood chicks to ensure they are fed. Domestic dogs occasionally prey on both eggs and birds.(Buick & Paton 1989).

Figure 6. A hooded Plover chick takes refuge from predators on the open beach in a footprint.

The coastline of the Port Wakefield Proof and Experimental Range is exposed to a different suite of potential threats due to its use as a munitions testing ground. Surveys conducted by Sinclair Knight Merz (SKM) 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.

Although the impacts of threats to migratory shorebirds have not been widely studied in Gulf St Vincent, they have been extensively studied elsewhere throughout the world. The loss or degradation of productive habitats where large numbers of shorebirds congregate appear to cause disproportionate declines in shorebird populations (Myers *et al*. 1987; Morrison *et al*. 2001; van de Kam *et al*. 2004; van Gils *et al*. 2006). For example, commercial shellfish dredging in the Dutch Wadden Sea, where large numbers of non-breeding shorebirds congregate, led to declines in both the quality and amount of food resources utilised by Red Knots, which caused a sudden and substantial decline in the knot population (van Gils *et al*. 2006).

Project Aims

This project aims to reinvigorate the monitoring of migratory shorebirds in Gulf St Vincent. Over the last 25 years, counts of migratory shorebirds have been conducted in Gulf St Vincent by volunteers from organisations such as the Australasian Wader Studies Group, Birds SA, and others. Nevertheless, as discussed previously, a more comprehensive effort is required. The objectives of the project, which were formulated to address these issues in Gulf St Vincent, include:

- Conduct shorebird counts at all known shorebird habitats within Gulf St Vincent, ensuring the data collected meets national standards.
- Conduct two training workshops to increase awareness of shorebird conservation and expand the available pool of volunteer counters.
- Report on historic count data in the region, map shorebird habitat in Gulf St Vincent, and identify any gaps in our knowledge about shorebirds in the area.
- Provide information that is relevant to land-managers to support planning which will minimise the impacts of development and human disturbance on shorebird habitat.

Figure 7. The Bar-tailed Godwit is one of the largest summer migrants to Australia and has been recorded to cover 11000km in one flight.

METHODS

Shorebird workshops

Two Shorebird Counting and Identification workshops were conducted in Adelaide in order to educate the local community about shorebird conservation and identification, and expand the pool of qualified counters in the Gulf St Vincent area. Workshops consisted of a presentation on shorebird ecology and conservation, presented by Lainie Berry, followed by a presentation on shorebird identification and counting methods, conducted by Rob Clemens and Chris Purnell. Participants were provided with fact sheets outlining survey methods, as well as shorebird identification booklets to be used in the field.

The first workshop was held on 22 February at the Watershed Function Centre, Mawson Lakes, and was followed by field trips to Thompson Beach and Barker Inlet Wetlands. The second workshop was conducted on 14 March in the Royal Society Rooms of the South Australian Museum. This was followed by a fieldtrip to the Third Creek, south of Thompson Beach.

Participants in the workshops were recruited by using existing Birds Australia contacts as well as the extensive contact lists of Tony Flaherty (Mount Lofty Ranges NRM), Sarah Pearson and Trevor Cowie (Birds SA). Flyers advertising the events were also posted on noticeboards on three university campuses in Adelaide.

Figure 8. Rob Clemens delivers a presentation on the identification of shorebirds at the Watershed Convention Centre.

Shorebird Surveys: Study Area

The study area included the outer harbours Section Banks, Troubridge Island and two saltfields, as well as coastline and surrounding habitat stretching as far south as Carrikalinga Beach (35°25'39"S, 138°18'51"E) on the east coast, and Sheoak Beach (35°09'20"S, 137°41'06"E) on the west coast. This area, which regularly supports up to 27 000 shorebirds, was broken up into 32 discrete count areas (Fig. 9). Each count area has distinct boundaries that were devised using a combination of geographic markers and what was considered to be a reasonable area for people to easily conduct repeat surveys. Counters were asked to stay within these boundaries and complete their Shorebird Counts Forms with data including the name of the count area, start and finish times, tide conditions, disturbances and species observed (Appendix E). This report and attached GIS layers, including count area boundaries, should be utilised when training new counters to ensure the count areas used remain consistent.

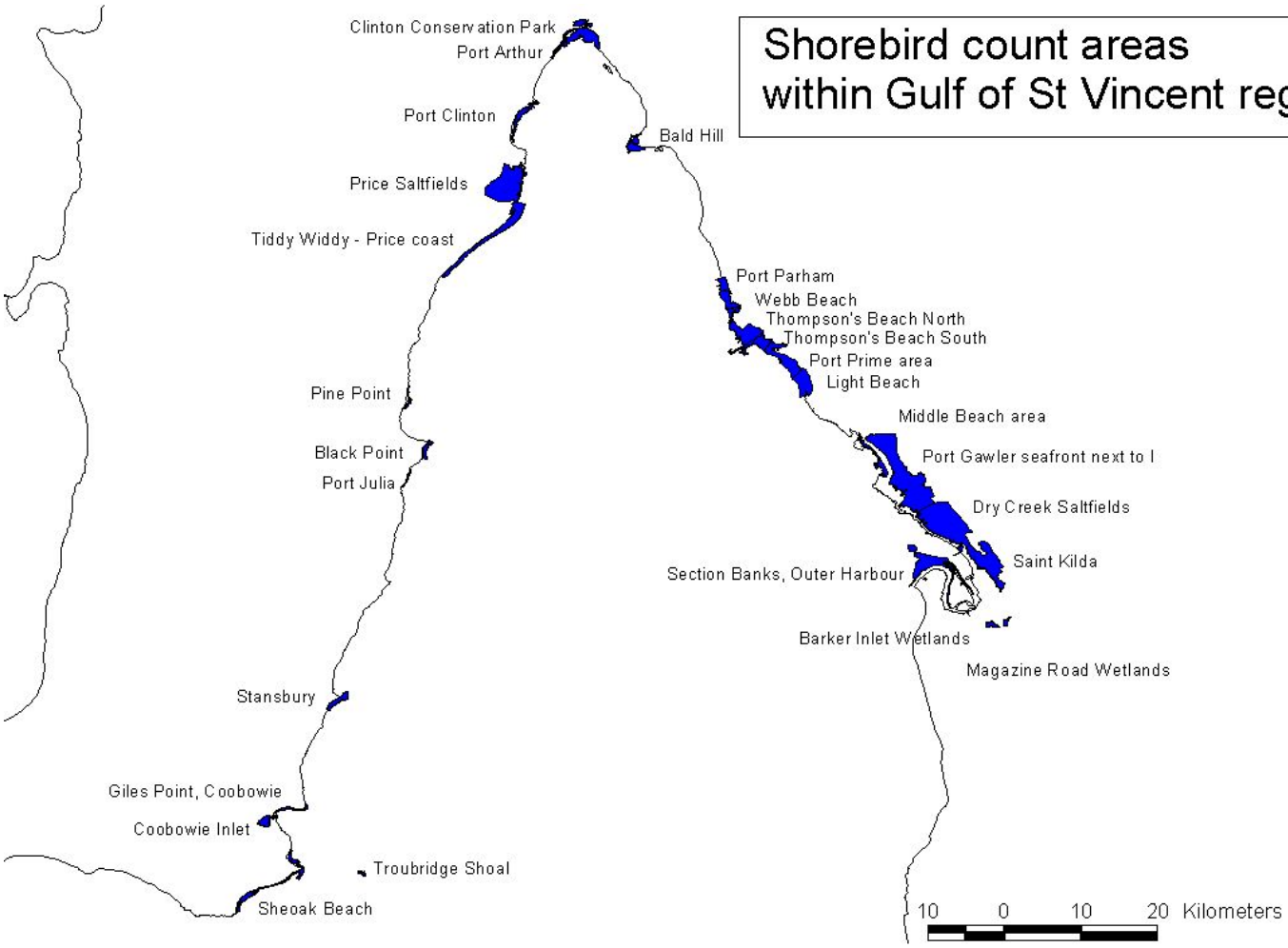

Figure 9. Map of the areas where shorebirds were counted within Gulf of St Vincent.

The study area in Gulf St Vincent contains three known important areas for shorebirds: Clinton Conservation Park, Dry Creek Saltfields (formerly Penrice and ICI) and Price Saltfields. The Dry Creek and Price Saltfields comprise 4000 and 1064 hectares of evaporating ponds, respectively, and they are surrounded by saltmarsh, mangrove and mudflats.

Consultation

Before the project commenced, staff from Birds Australia met with representatives of the local Natural Resource Management Regions and Birds SA. These meetings were used to introduce the project representatives to the local birders and land managers in order to assess the need to gather information on shorebirds.

2008–09 Field Survey

Field surveys were conducted in 2008–09 to determine the geographic extent of important shorebird areas, with a focus on mapping roosting and feeding areas. Local knowledge was utilised to identify sites regularly used by shorebird, though experimental exploration also played a large part in many areas. For this reason, gaps in our knowledge of roosting sites may still persist (this is discussed later in this report).

Surveys were conducted by Chris Purnell in conjunction with a contingent of volunteers and local shorebird experts over an extended period, with two Gulf-wide counts, organised by Trevor Cowie, on 29 November 2008 and 28 February 2009. All surveys were conducted on land, except those on Troubridge Island and Section Banks, which involved surveys of islands and sandbars by boat at low tide. Surveys were conducted throughout the tide cycle, though surveys of roosting areas focused on high tide. Some time was available to survey feeding shorebirds at low tide, as well as on rising and falling tides, but the documentation of feeding sites in the Gulf remains incomplete.

These were the first comprehensive, simultaneous surveys conducted in Gulf St Vincent since February 1981. Historically, the main three sites (Dry Creek Saltfields, Price Saltfields and Clinton Conservation Park) were counted at least annually between 1981 and 1990, with winter and summer counts being conducted in most years, with more sporadic counts conducted after 1990.

The survey on 29 November was conducted by 42 volunteers at 17 count areas. These area were: Aldinga Reef, Aldinga Washpool, Barker Inlet Wetlands, Black Point, Carrickalinga, Dry Creek Saltfields, Magazine Road Wetlands, Port Arthur, Middle Beach, Giles Point Coobowie, Port Clinton, the coast between Port Gawler and Middle Beach, Port Parham, Port Prime, Price Saltfields, Thompson Beach and Webb Beach.

The survey on 28 February was conducted by 24 counters at 13 count areas. These count areas were: Dry Creek Saltfields, Port Parham, Port Prime, Middle Beach, Light Beach, Thompson Beach, Port Gawler, Webb Beach, Port Julia, Port Arthur, the coast between Port Gawler and Middle Beach, Magazine Road Wetlands and Port Clinton.

Google Earth satellite imagery with GIS overlays of existing count areas and possible shorebird habitats were used in the field. Most of the features identified on the images were sufficiently obvious to allow the boundary of shorebird areas to be drawn on the photos, but in areas where boundaries were unclear, GPS points that bounded the shorebird area were collected.

Collation of Data

All shorebird count areas identified on the GIS maps were surveyed between November 2008 and March 2009. These records were supplemented by historical data where current count data for specific count areas were inadequate or were unrepresentative (according to local experts) due to confounding factors such as unfavourable tides or poor visibility. For example, Troubridge Shoal and Section Banks both required boat surveys, and, as a result, these sites were only surveyed once during summer 2008–09.

Maximum and average counts for each species (Appendix 1) were analysed in relation to significance thresholds derived from population estimates provided by Bamford *et al*. (2008). For populations of migratory shorebirds in Australia, an area is regarded as internationally significant for a species if it supports 1% of the flyway population; and it has been proposed that any area supporting more than 0.1% of the flyway population be considered nationally important.

As access to the Defence Force Proof and Experimental Range was denied, our data from this section of coastline and its associated saltmarshes was supplemented by biodiversity surveys conducted by private consults for the Australian Defence Force in 2007.

It is important to note that a number of rare and interesting species of shorebirds, such as the Hudsonian Godwit, Red-necked Phalarope, American Golden Plover and Cox's Sandpiper (a rare Pectoral × Curlew Sandpiper hybrid), have been recorded in Gulf St Vincent (especially at Dry Creek and Price Saltfields) outside our official surveys

GIS mapping

Boundaries of count areas were digitised on screen-displayed digital ortho-photos in ArcView 3.2, based on the hand-drawn boundaries on the field set of photos. The accuracy of these photos was confirmed by the comparison of GPS ground control points with physical features. Historical shorebird feeding areas were based primarily on a report which plotted polygons over shorebird areas (Close 2008). Only the likely features in current photos were used to form the boundaries of historic feeding areas. Due to the variable nature of coastal environments, this meant that the polygons may not have reflected the true historical boundaries. The attribute table was created in Excel, and then imported into ArcView. Specific information on the GIS data including the projection used, attributes and the like are shown in the metadata (Appendix D).

Mapping of roost and feeding sites was based on field observations, but suspected feeding areas were also mapped by using local knowledge and habitat maps (Coleman 2008 pers comm). Suspected feeding areas are particularly important in reference to areas used by birds during spring tides. When a spring tide occurs, the inundation greatly reduces the area of available feeding habitat for shorebirds, especially for

small species. Feeding birds are forced inland to feed or roost in saltmarsh, such as at Third Creek, which remains largely dry except during exceptionally high tides. Thus, these sites are some of the most valuable for shorebirds, and they are susceptible to threats.

Figure 10. Bakers Creek , south of Thompsons Beach, is a favourite roost site for several species of shorebird.

Identification of threats

The identification of potential threats to shorebirds was based on a comprehensive review of all relevant literature (Appendix C). In Gulf St Vincent, potential threats fall into five categories: (1) human-induced habitat loss or degradation; (2) human disturbance; (3) invasive species; (4) pollution; and (5) human-induced mortality or breeding failure. These threats were scored by counters using a technique developed by the Western Hemisphere Shorebird Reserve Network (see Table 2). The maximum threat score from the five categories was reported, along with the sum of the five threat scores for each area (Appendix B). While this technique is subjective and results varied between counters, it allows comparisons between potential threats (Clemens *et al*. 2007).

Table 2. Description of threats to shorebird areas and how threats were scored

Types of Threats Identified and Scored:

Human-induced habitat loss and degradation
Human-induced disturbance
Invasive species/habitat loss or degradation due to natural causes (vegetation encroachment)
Pollution (oil spills, runoff, or anything that changes soil texture, elevation, pH, toxicity, turbidity etc.)
Accidental mortality (not including oil spills; primarily refers to direct or indirect mortality during breeding for species, such as trampling of nests by vehicles, people etc.)

Scoring:

Timing of each threat type:	Timing Threat Score
Happening now	3
Likely in the short term (< 3 years)	2
Likely in the long term (> 3 years)	1
May have happened in the past but not likely again	0
Scope of each threat type:	**Scope Threat Score**
Whole area/population (>90%)	3
Most of area/population (50–90%)	2
Some of area (10–49%)	1
Small area	0
Unknown	1
Severity of each threat type:	**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 (1–10% 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
Then maximum threat score was reported
and the sum of threat scores was reported across five threats (max = 45)

RESULTS

Shorebird Workshops

The shorebird workshops conducted in early 2009 attracted audiences from various backgrounds and with different birding experience, with 80 and 29 participants attending the events on 22 February and 14 March, respectively. Of the 48 participants who completed online surveys after the workshops, 65% of attendees of the February workshop and 50% of the attendees of the March workshop classified themselves as beginners in terms of shorebird identification. The remainder classified themselves as intermediate.

Further results from the online survey reported:

- 53% of attendees of February and 67% of March workshops stated that they "learned enough to begin to try some counting on my own, but would prefer to be paired with more experienced counters for official counts"
- 59% of attendees of February and 66% of March workshops stated they were "probably" or "definitely" going to complete a shorebird count following the workshops.

Overall, 40.5% of participants of the February event rated the workshop and fieldtrip as "excellent", and 56.8% rated them as "good"; in March, 64% rated them as "excellent" and 18% as "good" (L Berry pers comm2009).

Mapping

A total of 32 shorebird count areas were identified and mapped within ArcGIS (Maps 1–5 in Appendix A). These areas comprise nine roosting areas, 17 feeding and roosting areas and 16 discrete feeding areas, one of which spans 57 kilometres of coastline. Two areas of Hooded Plover habitat were also identified. The boundaries of all areas and the attributes associated with them are available within the created GIS layer, but maps can also be viewed in Appendix A; many attributes for each shorebird area are presented in Appendix B. Fieldwork investigating shorebird habitat was mostly conducted at high tide in order to locate roost sites. However, several low-tide surveys were conducted, and opportunistic sightings of feeding birds were also recorded. As large areas are involved, together with issues involving land ownership and accessibility, further studies are required to document potential feeding and inland roosting areas in Gulf St Vincent.

Threats to shorebird areas in Gulf St Vincent

Three shorebird areas were identified as being under high levels of threat. The shorebirds at Salt Creek Cooboowie and St Kilda were under high threat from human-induced habitat loss. A further three coastal townships support shorebird habitat which is under moderate threat from loss of habitat.

Another shorebird area, Pine Point, was under high threat from human disturbance, and, overall, 22 shorebird areas were under current threat from human disturbance. Of the remaining 21 areas, 17 were identified as under moderate threat from various human activities. Many of these sites are associated with coastal towns which host recreational activities in shorebird habitat for residents and many visitors from Adelaide. The presence of resident coastal communities also increases the threats posed by invasive species: nine areas were under moderate threat from invasive faunal species, such as domestic pets and foxes.

The Price and Dry Creek Saltfields (Fig 10) were identified as areas where shorebirds were under the highest threat from accidental mortality (that is, being run over by vehicles). However, the extensive use of the coastline north of Ardrossan (from Tiddy Widdy to Price) by off-road vehicles is of concern, especially for resident shorebirds, such as the Red-capped Plover.

Figure 11. Red-knecked Avocets feed in the hypersaline evaporation ponds of Dry Creek saltfields.

Pollution was considered to be a moderate threat to shorebird habitats at four sites that are near heavily developed areas or areas with high levels of off-road traffic.

This assessment of threats did not include an assessment of the threats to shorebird areas in the immediate Adelaide area, but planned development in this region could result in the greatest loss of shorebird habitat and numbers of anywhere in the Gulf.

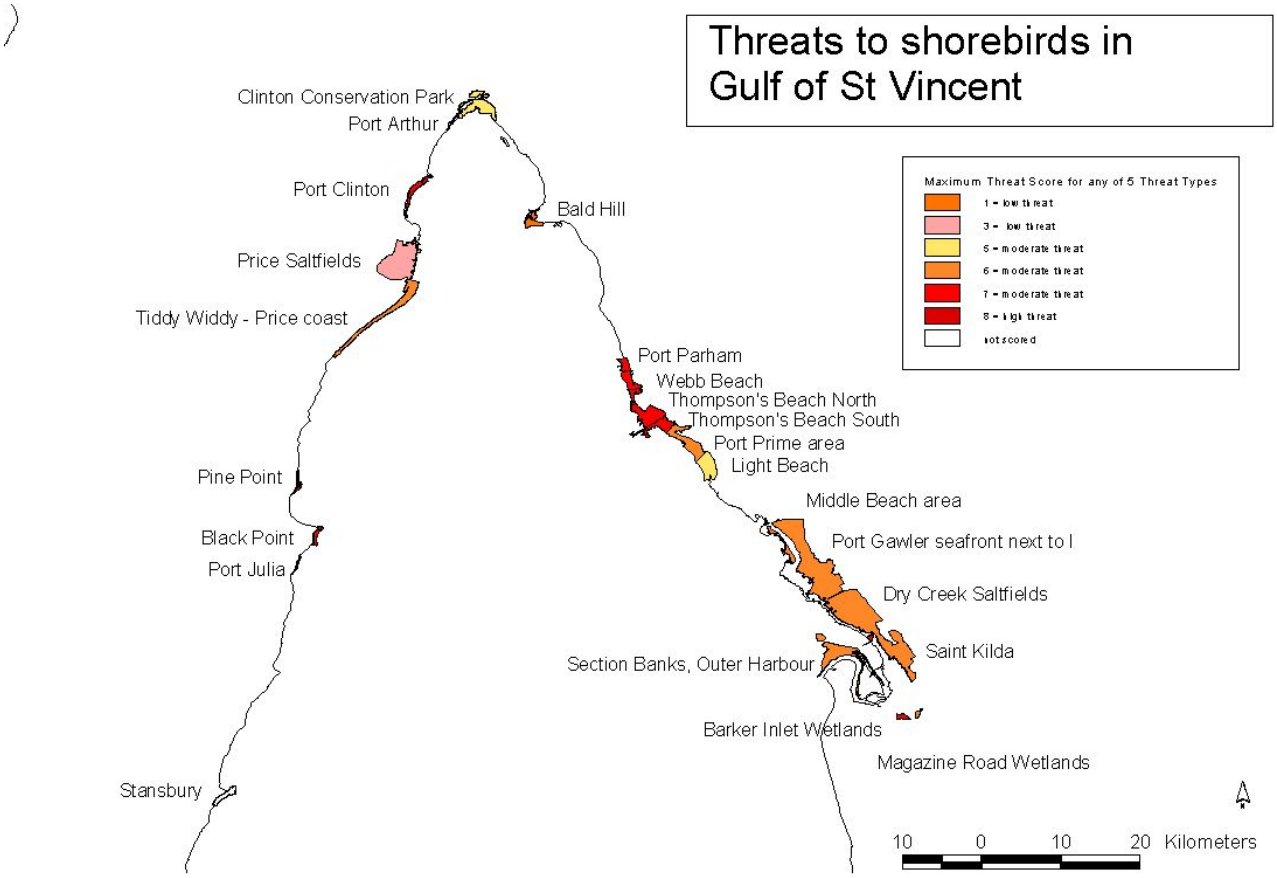

Figure 12. The relative threats to shorebirds in Gulf of St Vincent. The areas around Adelaide hold some of the largest concentrations of shorebirds in the Gulf, and therefore while threats were not scored high in this area, without protection from development and other impacts the loss of this area's habitat to shorebirds would be severe.

Relative importance of shorebird count areas

Recording the number of shorebirds and the number of species of shorebirds using an area allows a comparison of the relative importance of each area for migratory shorebirds (Tables 3–6).

The maximum number of shorebirds observed in each count area during surveys in Gulf St Vincent are shown in Table 3. Results from surveys conducted over 25 years show that Dry Creek and Price Saltfields support the highest abundance and diversity of shorebirds, with nine species observed in significant numbers in Dry Creek and 14 in Price. A further 23 of the 33 count areas held at least one species in significant numbers (Table 3). Of particular note is the area known as the "Samphire Coast". This almost continuous stretch of coast, supporting much shorebird habitat, starts at Port Gawler and continues north for 57 km to Bald Hill. For counting purposes, this area was broken into nine separate count areas: Port Gawler seafront next to ICI Saltworks, Middle Beach, Light Beach, Port Prime, Thompson Beach (North and South), Webb Beach, Port Parham, Proof and Experimental Range and Bald Hill. Together, these nine areas supported an average of nearly 10,000 shorebirds.

Accompanying the maximum numbers of shorebird species shown in Table 4 is a list of significance thresholds for each species, based on estimated national populations

(Bamford *et al*. 2008). A total of 18 species were recorded in significant numbers at various sites in Gulf St Vincent. Maximum numbers recorded in historic counts between 1985 and 2005 are listed in Table 5. In a review of trends in shorebird numbers in the Gulf between 1985 and 2005, Close (2008) stated that maximum numbers of 24 of the 34 species (70.6%) observed were recorded between 1985 and 1995; they have not been exceeded since then, despite annual surveys in the three key shorebird areas. Population declines are more evident among migratory species than resident species, with species such as the Curlew Sandpiper continuing a well-documented decline in population in south-eastern Australia (Gosbell & Clemens 2007). A maximum of 3250 Curlew Sandpipers was observed at Dry Creek Saltfields in 1986; by 2008 ands 2008, this had declined by 85%. Dry Creek and Price Saltfields held the largest populations based on the 1981 -2009 averages.

Price Saltfields supports the greatest diversity of species of shorebirds in the Gulf, with a total of 31; some other areas which support smaller populations also have great diversity: Clinton Conservation Park had an average of nearly 6000 shorebirds of 27 species; and Port Parham, which is ranked fourth in the Gulf in terms of diversity, supporting 24 species, though it averaged only 1600 birds. Conversely, Port Wakefield supported an average of over 5500 shorebirds, but they comprised only 12 species.

Results from the Gulf-wide surveys of 29 November and 28 February shed some light on the total abundance of shorebirds in Gulf St Vincent (Tables 7,8). A total of 29 species were observed on 29 November and 30 on 28 February; 11 of the species were recorded in significant numbers in relation to their national population estimates.

It is important to note that counts derived from SKM's environmental audit of the Proof and Experimental Range only focused on two small areas of coastline (the "Groyne area" and "x14"; SKM 2007) and may not be representative of the area due to the nature of survey methods described. These areas are identified in the audit as the areas of greatest shorebird and waterbird abundance, but the report does not mention observations of birds outside their boundaries. During these historic surveys, large numbers of shorebirds were observed along the Proofing Range coastline, including seven species in nationally significant numbers.

DISCUSSION

Shorebird Workshops

The results of online surveys and general feedback indicated that the shorebird workshops and associated fieldtrips on 22 February and 14 March were successful in raising awareness of the need for shorebird conservation and training new potential counters for the area. The number of participants who classified themselves as beginners and intermediates demonstrates that although Adelaide and Gulf St Vincent support a very active birding community, shorebirds receive little acknowledgement. This situation is common in many areas due to difficulties experienced in identifying shorebirds in non-breeding plumage.

The preference of the majority of participants to be paired with experienced counters provides excellent impetus to organise further field trips, as opportunities exist for novice counters to be grouped with more-experienced counters in simultaneous Gulf-wide counts. This would involve much organisation, but advertising of specific dates and count sites to be covered may elicit interest from a larger pool of people if they are afforded the convenience of the option of counting at various sites. The Gulf-wide counts in November and February developed a good platform from which to expand, with several designated "team leaders" being accompanied by up to six other counters.

There was also much interest from people who were unable to attend workshops. Therefore, regular ongoing shorebird workshops and field trips are recommended to sustain interest in the project and offer potential counters further experience. Birds Australia is willing to provide presentations, materials and any training needed for organisations to lead workshops

Mapping of Important Areas for Shorebirds

The field survey conducted in 2008-2009 enhanced the previous understanding of which areas in Gulf St Vincent are important for shorebirds. Specifically, the spatially accurate digital ortho-photos, and on-the-ground GPS coordinates facilitated a spatially explicit accuracy of shorebird area boundary mapping never before completed for this area. Furthermore, this recent fieldwork apparently marked the first time some areas have been surveyed for shorebirds. In particular, the great abundance and diversity recorded at Bald Hill and along the southern coastline adjacent to Price Saltfields were noticeably absent from count data spanning 20 years.

Given the large area that is inaccessible by land due to impenetrable mangroves or government or private land use, it is likely that some important shorebird areas remain unidentified. This is especially true for areas used by migratory shorebirds for feeding or for roosting at low or small neap tides. In these cases, future surveys should be conducted by boat. Gaps in our knowledge are evident for mangrove-bordered mudflats and associated estuaries adjacent to Dry Creek Saltfields, as well as in the extensive saltmarsh area to its north. The northern patches of coastline adjacent to Price Saltfields also remain unsurveyed. Areas of coastline and saltmarsh that fall within the boundaries of the Australian Defence Force Proofing and Experimental Range provide perfect habitat for shorebird feeding and roosting. During the 2008-

2009 surveys, feeding and roosting birds were observed at its northern and southern boundaries, but access to the proofing range was denied for this survey period. Therefore, historic data, including SKM's 2007 biodiversity audit and mapping of roost sites, were used to supplement our own data. With the cooperation of the Australian Defence Force, a comprehensive survey by shorebird experts is suggested for this area, followed by at least two shorebird surveys each year.

The 2008-2009 survey focused on migratory shorebird roosting habitat. Surveys conducted at low tide allowed the identification of feeding areas that held high densities of migratory shorebirds. However, this survey was the first attempt to quantify the spatial use of tidal flats for feeding in the area, and more work is needed before all the feeding areas can be identified and their relative importance understood. Some species, such as the Eastern Curlew, are sparsely scattered when they feed on tidal flats. Areas of tidal flats used by shorebirds at low densities have been mapped as feeding areas, as have suspected shorebird feeding areas that were identified using local knowledge and habitat-type mapping. Historical maps combined with spatial habitat data were used to recognise areas which share attributes with identified shorebird feeding areas, resulting in more inclusive mapping. The relative densities of feeding birds in these cases will be reflected in survey results.

Some of the shorebird areas which have been identified have been surveyed regularly for over 25 years during counts of migratory roosting shorebirds. This history of surveys allowed for a comprehensive understanding of where future surveys of roosting shorebirds should be conducted, and the number of shorebirds that these habitats support. As previously indicated, some areas had not been surveys for shorebirds for years. The 2008-2009 surveys identified new roosts and feeding areas at these sites, and additional roosts might possibly be found if further surveys are conducted under different tide conditions. Shorebird areas for species that tend not to congregate or only occur as vagrants were poorly represented by the shorebird areas identified in this study.

Of the mapped roosting areas, Dry Creek and Price Saltfields contained the largest areas of roosting habitat. However, due to the temporal difference in both water and salinity levels in any particular evaporation pond, birds will change their feeding and roosting sites depending on these conditions. Thus, when mapping, all evaporation ponds were classified as "feeding and roosting areas". The associated mudflats that were earmarked earlier in this report for future surveying have been mapped simply as "shorebird areas", with no mention of feeding or roosting habitat.

Figure 13. Salt deposits bordering evaporation ponds at Salt Creek provide ideal roosting spots for small waders

Finally, the 2008-2009 survey has allowed much-improved mapping of the distribution and extent of shorebird habitat in Gulf St Vincent. Nevertheless, it is

important to remember that most tidal flats and coastal areas support small numbers of shorebirds, and the information presented here may be incomplete.

Positional accuracy of mapping

The supply of digital ortho-photos enabled relatively easy and accurate mapping (Appendix D). Shorebird habitat extents were drawn directly onto printouts of digital ortho-photos from Google Earth with the assistance of GPS coordinates where obvious geological landmarks were absent. Digital ortho-photos were found to be spatial accurate after comparisons with GPS field points. GPS readings fluctuated by up to 10 m in the field, but despite variation in spatial accuracy of mapping, all of the spatial boundaries are believed to include the core of the important habitat, and this estimate of spatial accuracy generally applies only to the edges. In some cases the actual edge of the mapped shorebird habitat was uncertain, and where boundaries are not well defined our boundary and the boundary the birds use may be off by as much as 50 m.

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 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 and as the distribution of benthic organisms shift.

Accuracy of number of shorebirds reported using each area

The number of shorebirds reported here will vary in accuracy depending on the number of times an area was surveyed, and how recently it was surveyed. Generally, however, the overall maximum and average number of shorebirds (Apendix 1) reported in the region will be relatively accurate, but due to the transitory nature of shorebirds and the continuity of appropriate feeding habitat, it is possible that some birds may have been missed or double-counted.

For discrete roosting and feeding areas within the Gulf, the accuracy of the data varies with increasing accuracy for areas visited more often and more recently. The surveys of 2008-2009 represent the most comprehensive counts of Gulf St Vincent; therefore the data presented in this report are temporally relevant to the current state of shorebirds and their habitat. Habitat usage varies under different conditions, and it is for this reason that counters are asked to note variables such as tide height, time of day and wind speed, and are encouraged to comment on anything else they may consider a factor influencing habitat choice (Appendix C). An increase in the robustness of the data and the accuracy of condition-dependant habitat mapping should be facilitated by:

- an increase in the number of active counters from around the Gulf
- the identification and segmenting of distinct count areas, and
- the implementation of the universal survey methods introduced by Shorebirds 2020.

Consistent, simultaneous Gulf-wide counts are also recommended, with the quality of data expected to increase as counter numbers and count areas surveyed increase. A notable exclusion from previous Gulf-wide surveys was Clinton Conservation Park;

given its conservation status, this area remains undeveloped and can be difficult to navigate through, and only a handful of counters have conducted surveys there. However, survey routes to shorebird feeding and roosting habitats have been provided, approved and commented on by local experts during the 2008 -2009 mapping project and will be supplied to counters. This will allow more surveys of this important area to be conducted in the future.

Identification and location of threats to shorebirds in Gulf St Vincent

Habitat loss or degradation

Habitat loss and degradation is the most formidable long-term threat to shorebird populations in Gulf St Vincent. For example, large areas of tidal mudflat at St Kilda have been reclaimed and built upon, including a boat launch and marina, which also encourages disturbance from boat users, the potential for pollution and the introduction of coastal weeds from unclean boats. In addition, the impact on shorebird habitat of reinstating the tidal flow to Salt Creek is unclear. The construction of a culvert to restore flow and improve fish nurseries has, on one hand, restored the benthic invertebrate communities, which encourages shorebirds to feed on rising and falling tides on the seaward side of the inlet (Treloar, K 2009, pers. comm.). On the other hand, it has been noted that the inner reaches of the inlet now remain almost permanently inundated. This reduces significantly feeding and roosting habitat on the landward side of the inlet, with water levels remaining too deep for small and medium-sized waders (Close 2008; J. Oldland, 2009, pers. comm.).

Among other developments, proposals from Delfin to develop areas of Salsibury which abut the Dry Creek Saltfields threaten to cause the greatest impact on shorebird habitat in Gulf St Vincent. The development would require vast areas of low-lying saltmarsh to be filled in, as well as the relocation of many of the saltfield's northern evaporation ponds, which currently support large numbers of resident and migratory shorebirds. An increase in residential development may encourage an extension of the Northern Expressway, which would further impact on the local habitat. The Dry Creek Saltfields support an average population of nearly 15 000 shorebirds. Although it is difficult to gauge the extent to which such developments would impact on the shorebird population, migratory birds which congregate in large feeding and roosting flocks are likely to experience mass displacement and consequent population reductions throughout the Gulf. The disturbance created by such a large-scale development would displace many species, not only in construction areas, but also in adjacent habitat (Kellog *et al*. 2003).

Other notable shorebird areas susceptible to development pressure occur at Black Point and along the Samphire Coast. At Black Point, empty blocks on the dunes adjacent to the Black Point Reef are currently being sold. This area has been identified as an important feeding and roosting area for 13 species of shorebirds, including two beach-nesting species (Red-capped and Hooded Plovers) and nationally significant numbers of Red-necked Stints.

It is, therefore, important that the potential impacts of any development, proposed management or proposed human activity within 200 m of these important shorebird areas should be fully assessed.

Disturbance

Studies have shown that human disturbance of roosting shorebirds is related to local population declines (Burger 2004, Pfister *et al*. 1992; Tubbs *et al*. 1992), lowered body condition (Durell *et al*. 2005), regional habitat shifts (Burton *et al*. 1996) and local avoidance behaviour (Kirby *et al*. 1993). Boating traffic is a major source of disturbance of shorebirds which has led to long-term abandonment of roosts (Burton *et al*. 1996). 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*. 2003). 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 km (Peters et al 2007). Most shorebird areas in the Gulf do not currently receive high levels of boating traffic, but if the level increases it may reduce the number of available coastal roost sites for some species.

Disturbance is a prevalent threat to shorebirds in Gulf St Vincent, especially at beaches where resident shorebirds breed. Adults are easily disturbed by people in breeding areas, keeping adults from incubating or brooding, and breeding attempts can fail as a result; chicks are also easily disturbed. Unrestrained dogs are a major source of disturbance to nesting and roosting birds (Paton *et al*. 2000; Weston 2000).

The populous and much-visited Samphire Coast, including Thompson Beach and Webb Beach, is the migratory shorebird area most threatened 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 is a good example of this: during the 2009 low-tide surveys, boats were continually launched by driving tractors across a rocky reef and mudflat that were used by feeding shorebirds, and the remaining edges of tide-line were patrolled by crabbers, many of whom were accompanied by dogs, which constantly disturbed the feeding birds. Without historic counts for these areas it is difficult to gauge the effect increased human activity has had on shorebirds over time.

Crabbing seasons coincide with the arrival of thousands of migratory shorebirds to the Gulf. The Blue Swimmer Crab season begins in September and runs through summer as the crabs congregate inshore to breed, peaking in February, and then dispersing into deeper waters by April. Hundreds of crabbers may patrol the tide line, creating a constant disturbance for feeding and roosting birds.

Figure 14. Shorebird workshop participants stand amongst tyre tracks at the Third Creek Sabkha

Other recreational activities, such as jet skis, dirt bikes and para-surfing, at various sites in the Gulf all discourage shorebird feeding and roosting, and their results of multiple disturbances have been recorded at many places, including Port Parham, Port Gawler, Light Beach and at sites throughout the Samphire Coast, especially Thompson Beach and Third Creek sabkha, important and sensitive high tide roosts.

Some form of disturbance occurs at most shorebird areas, but their effects are not fully understood. Observations suggest that disturbance at many areas is relatively frequent and 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 threatened by disturbance.

Invasive Species or encroachment on habitat by native vegetation

Introduced animals posed readily identifiable threats to shorebirds in Gulf St Vincent. Rats, foxes and domestic pets were all seen near shorebird areas during 2008 -2009 surveys, and are likely to pose a particular threat to resident shorebirds (especially Hooded Plovers and Red-capped Plovers) in the Gulf, manifested in reduced breeding success due to predated eggs and chicks (Weston 2000; DEWHA 2008); a fox was seen within 10 metres of a Hooded Plover nesting site at Port Julia (Chappel, 2009, pers. comm.). Elsewhere, the contents of one fox stomach examined in Western Australia contained the remains of 38 Red-capped Plovers (Geering *et al*. 2007). Adults are also susceptible to predation during breeding periods.

Along the eastern shore of Gulf St Vincent, the area vegetated with mangroves increased at a rate of 17 m each year between 1949 and 1979 (Saintilan & Williams 1999). There are many possible explanations for this trend. It has been suggested that the increased annual precipitation in the area since 1945 may have diluted salt levels within saltmarsh soils to the extent that mangrove colonisation was enhanced (Saintilan & Williams 1999, 2000). Increased nutrient levels and sedimentation from agriculture are also considered a possible cause of increased mangrove growth (Hughes 2003; Straw *et al*. 2006).

Figure 15. Mangrove die-off amongst salt-marsh at Dry Creek saltfields.

The expansion of the Grey Mangrove is viewed as unnatural in south eastern Australia, resulting in pressure being exerted from residential and coastal development, planning and management authorities to remove and destroy mangroves, partly for protecting and re-instating other impacted habitats such as saltmarsh and mudflats (Harty 2009). Estuary management planning is a useful tool that can integrate and balance policy directions for mangroves and other estuarine habitats in a strategic manner (Harty 2009). 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 mudflat and saltmarsh habitat, are currently being undertaken to conserve shorebird habitat in Hong Kong (Straw *et al*. 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 the Gulf, such as Dry Creek saltfields, natural die-off of mangroves is exceeding growth.

Marram Grass is recognised as an environmental weed, but on the beaches south of Outer Harbour, where it is abundant, it is a functional species used as a sand stabiliser for slowing sand movement along artificially maintained metropolitan beaches. The spread of Marram Grass poses a threat, and its containment is a priority noted by several councils. Sea Spurge is a species that has received much attention on the southern beaches in particular 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. The threat from African Boxthorn and Tree Mallow is, so far, restricted to urban beaches, where they may impact on potential shorebird nesting areas, such as in Section Banks (Carpenter 2008) and the Samphire Coast (Jensen 2004). The threat from these environmental weeds is recognised by local councils and control measures are in place.

Human-induced mortality or breeding failure

Several sandy beaches around the Gulf are under threat of accidental, human-induced mortality or breeding failure. In these areas the threat is primarily due to well-camouflaged eggs or chicks that are accidentally stepped on or run over by vehicles. Eggs of Hooded Plovers and Red-capped Plover are well camouflaged and are laid directly onto the sand, so they are especially susceptible to accidental crushing underfoot. Chicks are also relatively easy to overlook and trample. Of the important Hooded Plover areas identified in the Gulf, only one site, Aldinga Beach, is popular with beachgoers. Reports from the Aldinga Bay Coastcare Group attribute minimal breeding success mainly to disturbance by vehicles, and are currently seeking a vehicle-free zone to be declared for the coastline across the width of the Washpool area.

Figure 16. The camouflage of Red-capped Plover chick.
Photo: Purnell Collection © Australian Museum

Figure 17. A Red-capped Plover nests on the sand.
Photo: Purnell Collection © Australian Museum

The greatest threat of accidental human-induced mortality or breeding failure occurs at Dry Creek and Price Saltfields. Access tracks running between the evaporation ponds in Dry Creek Saltfields are favoured by Red-capped Plover as nesting sites, and during car-based monitoring surveys in February 2009, only vigilant driving prevented many chicks from being run over. The narrow width of these roads means that chicks have few escape routes, and some were seen trying to outrun cars. Exacerbating the issue is the recommendation that vehicles in the saltworks should not deviate off their driving line or slow down in certain areas due to the poor condition of the roads.

Unrestrained dogs can step on or eat eggs and chicks. This is thought to be a major cause of declining Hooded Plover populations in eastern Australia (Weston 2000).

Pollution

The threat of pollution in the shorebird areas of Gulf St Vincent is focused around Port Adelaide. The boat traffic in the upper Gulf is relatively low, but should an oil spill occur, the effects could be catastrophic to shorebird populations and long-lasting. Further, industrial development or increased capacity for more boats would increase the threats of a spill in these areas (Clemens *et al*. 2007).

> *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 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, which was passed by Parliament in 1984 to mirror Commonwealth legislation, has not been proclaimed. Therefore, the regulation of sea dumping in coastal waters currently rests with the Commonwealth. The Environment Protection Authority (EPA) is currently reviewing the South Australian Act to align it, with subsequent modifications, to the Commonwealth's sea dumping legislation. The 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)

Further, run-off from the areas water catchments, waste water, 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 massive die-off in sea grass populations in the Gulf (Coleman & Cook 2003; Close 2008). The potential impacts of run-off from the proposed intake of toxic chemicals and heavy metals at Dublin's Integrated Waste Services (IWS) northern landfill is a current matter of conjecture between the local council, residents and IWS. The installation of a high-temperature waste-disposal system would drastically reduce the 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 Port River Barker Inlet area, including valuable feeding areas such as Section Banks (Bryars 2003). In addition, in some areas, increased agricultural run-off with high nitrogen content has been shown to initially increase the diversity of invertebrates in the mudflats used by foraging shorebirds, but excess nitrogen will lead to eutrophic conditions, which kills the available food for shorebirds (van de Kam *et al*. 2004).

The important role that local planners, and managers play in protecting shorebirds and their habitats

The greatest threats to shorebirds in Gulf St Vincent can all be mitigated through the actions of local planners and managers. Furthermore, without the past actions of planners and managers in the area, the threats to migratory shorebirds would be greater, and shorebird populations could possibly have been further reduced in the region. For example, the Mallala City Council and the establishment of the Mallala Foreshore Advisory Committee, the Foreshore Task Group and associated networks are committed to the protection and environmental integrity of the Samphire Coast. This coastline has been identified as an important shorebird habitat. The Samphire Coast Conservation Strategy also recognises the significance of this habitat for the conservation of shorebirds in the Gulf (Jensen 2004). The strategy outlines provisions which must be undertaken to sustain coastal environments and establish an interconnected system of proposed protected areas, including land- and marine-based parks and Ramsar listing within five years. The recent establishment of the Samphire Coast Shorebird Trails, with accompanying signage and information booklet, is a prime example of local councils working in conjunction with coastal care groups and local residents to raise awareness of shorebird conservation to encourage pride in a regional project.

The creation and maintenance of wetlands near Dry Creek Saltfields by the City of Port Adelaide Enfield is a good example of councils reclaiming land for conservation and educational purposes. These wetlands comprise the Barker Inlet wetlands (about 50 hectares), which always contain brackish and salt water, and the Greenfields Wetlands, which consists of 114 hectares of fresh water at fluctuating levels. Situated within 20 minutes' drive of Adelaide's CBD, this project spreads awareness of shorebird conservation.

To maximise the conservation of shorebirds in Gulf St Vincent, it is vitally important that all planners and land managers in the region are aware of the important shorebird areas, and are able to give a high priority to the importance of the 34 areas that occur in the Gulf. Incorporating the spatial shorebird GIS layers into existing environmental overlays would go a long way towards informing decision makers in the region of which areas are most the important for shorebirds. Further, by making the information about shorebirds readily available, the chance of planning and management activities adversely impacting shorebirds should be reduced (Appendix C).

RECOMMENDATIONS

1. Ensure the protection of the habitats that support remarkable numbers of shorebirds in Gulf St Vincent.

2. Educate the public through signs, brochures, meetings and the like of the impacts they can have on resident and migratory shorebirds when they visit these important shorebird areas.

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

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

5. Consider a vehicle exclusion area for the coastline adjacent to and south of the Price Saltfields.

6. Priority for migratory shorebird conservation should focus on threatened areas as well as those areas that provide habitat for the largest number of individuals or species.

7. Discourage human activity around important shorebird areas, especially activities that exclude shorebirds from an area for prolonged periods, such as long-term summer camping within these areas. Further, discouragement of the use of loud watercraft within 250 m of these areas when shorebirds are present. Generally, a 200-m buffer to disturbance around these areas should be encouraged, with the understanding that shorter effective buffer distances can be identified on a case-by-case basis (for example, most boating appears to be tolerated within 50 m of shorebirds).

8. Encourage dog walkers to use a leash when in a shorebird area.

9. Surveys for breeding shorebirds should be encouraged in order to identify and protect easily impacted breeding areas.

10. Continue to control and remove the invasive Sea Spurge from effected 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 can be difficult to control once established.

11. 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.

12. Ensure that rigorous assessments of impacts to shorebirds are conducted for any planned activity or development that are likely to impact within 200 m of these important shorebird areas, or any area of tidal flats.

13. Work cooperatively with adjacent management units when potential impacts span multiple areas, or when activities from adjacent areas can affect shorebird areas, such as activities on the mainland that increase pollution in shorebird habitat.

14. Conduct thorough, year-round surveys of migratory shorebird feeding areas throughout Gulf St Vincent, taking particular note of the neglected areas mentioned in this report. Recently discovered areas need extra attention to establish a baseline for population trends, including regular boat surveys of Section Banks and the inaccessible areas identified in this report.

15. Work in cooperation with the Australian Defence Force to organise comprehensive, regular, summer and winter shorebird counts of the Proof and Experimental Range.

16. Continue organised Gulf-wide counts at least twice yearly, including summer and winter counts.

17. Continue annual summer and winter monitoring of shorebird populations to enable the rapid identification of any local activities that may impact on shorebird populations.

18. Re-assess the threats by computing threat scores regularly to determine whether shorebird numbers are changing in response to changes in threat levels.

19. Conduct a follow-up mapping project to ensure that all areas are correctly identified in these spatially dynamic areas.

References

Bamford, M., Watkins, D., Bancroft, W., Tischler, G. & Wahl, J. 2008. *Migratory Shorebirds of the East Asian–Australasian Flyway; Population Estimates and Internationally Important Sites*. Wetlands International — Oceania. Canberra.

Baxter, C.I. 2003. Banded Stilt *Cladorhynchus leucocephalus* breeding at Lake Eyre North in year 2000. *South Australian Ornithologist* 34: 33–56.

Bryars, S. (2003) An Inventory of Important Coastal Fisheries Habitats in South Australia, Fish Habitat Program, Primary Industries and Resources SA, Adelaide.

Buick, A.M., & D.C. Paton. 1989. Impact of off-road vehicles on the nesting success of Hooded Plovers *Charadrius rubricollis* in the Coorong Region of South Australia. *Emu* 89: 159–172.

Burger, J., Jeitner, C., Clark, K., & Niles, L. J. 2004. The effect of human activities on migrant shorebirds: Successful adaptive management. *Environmental Conservation* 31: 283–288.

Burton, N.H.K., Evans, P.R., & Robinson, M.A. 1996. Effect on shorebird numbers of disturbance, the loss of a roost site and its replacement by an artificial island at Hartlepool, Cleveland. *Biological Conservation* 77: 193–201.

Carpenter, G. 2008. *Birds of Section Bank, Outer Harbour*. Unpublished report for Coast and Marine Branch, Department of Environment and Heritage, Adelaide.

CHASM, 2004. Monitoring Arctic-nesting shorebirds: An international vision for the future. Bulletin 103.

Clemens, R., Rogers, D. & Priest, B.. 2007. *Shorebird Habitat Mapping Project: West Gippsland*. Birds Australia report the WWF – Australia and the Australian Government's Department of Natural Heritage and Environment.

Close, D.H., & Mckrie, N. 1986. Seasonal Fluctuations of Waders in the Gulf St Vincent, 1976-1985. Emu 86, 145- 154

Close, D.H. 2008. Changes in wader numbers in Gulf St Vincent, 1979–2008. *Stilt* 54: 24–27.

Coleman, P., & Cook, F. 2003. Saint Kilda- restoration options. Report by Delta Environment for the St Kilda Progress Association, Adelaide.

Davidson, N., & P. Rothwell. 1993. Disturbance to waterfowl on estuaries. *Wader Study Group Bulletin* 68 (Special Issue).

DEH. 2005. http://www.environment.sa.gov.au/coasts/adelaide_background.html#factors

Delany,S., 2003. How many of the world's wader species are declining, and where are the Globally Threatened species? Wader Study group Bull.101/102:13

DEWHA, 2008. Threat abatement plan for predation by the European red fox. DEWHA, Canberra

Dowling, B., & Weston, M.A. 1999. Managing a breeding population of the Hooded Plover *Thinornis rubricollis* in a high-use recreational environment. *Bird Conservation International* 9: 255–270.

Durell, S.E.A.L., Stillman, R.A., Triplet, P., Aulert, C., Biot, D.O.D., Bouchet, A., Duhamel, S., Mayot, S. & Goss-Custard, J.D. (2005) Modelling the efficacy of proposed mitigation areas for shorebirds: a case study on the Seine estuary, France. Biological Conservation, 123, 67–77. Elner, R.W. & Seaman, D.A. (2003) Calidrid conservation: unrequited needs. Wader Study Bulletin, 100, 30–34.

Fitzpatrick, S., & Bouchez, B. 1998. Effects of recreational disturbance on the foraging behaviour of waders on a rocky beach. *Bird Study* 45: 157–171.

Geering, A., Agnew, L., & Harding, S. 2007. *Shorebirds of Australia*. CSIRO Publishing, Melbourne.

Gosbell K., & Clemens, R. 2007. Population monitoring in Australia: some insights after 25 years and future directions. *Stilt* 50: 162–175.

Harty, C. 2009. Mangrove planning and management in New Zealand and South East Australia – a reflection on approaches. *Ocean & Coastal Management* 52: 278–286.

Hughes, L. 2003. Climate change and Australia: trends, projections and impacts. *Austral Ecology* 28: page numbers?.

Hamilton, G., & Ingwersen, D. 2007. Submission by Birds Australia to Department of Sustainability an Environment on "Land and Biodiversity at the Time of Climate Change." White Paper

IWSG. 2003. Waders are declining worldwide. Conclusions from the 2003 International Wader Study Group Conference, Cadiz, Spain. *Wader Study Group Bulletin* 101/102: 8–12.

Jensen, A. 2004. *Samphire Coast Shorebird Trails: Thompson Beach, Northern Gulf St Vincent*. Wetland Care Australia for the Thompson Beach Ratepayers Association, Adelaide.

van de Kam, J., Ens, B., Piersma, T., & Zwarts, L. 2004. *Shorebirds: An Illustrated Behavioural Ecology*. KNNV Publishers, Utrecht, The Netherlands.

Kellogg, B., & Root Pty. Ltd (2003) *Barker Inlet Wetlands and The Range Wetlands: Bird Species Assessment.*

Kirby, J. S., Clee, C., & Seager, V. 1993. Impact and extent of recreational disturbance to wader roosts on the Dee estuary: some preliminary results. *Wader Study Group Bulletin* 68: 53–58.

Lawler, W. 1996. *Guidelines for Management of Migratory Shorebird Habitat in Southern East Coast Estuaries, Australia*. Unpublished Master of Resource Science thesis, University of New England, Armidale, NSW.

McGrath, M. 2006. *Planning a shorebird project to target 4WD impacts on sensitive shorebird habitat*. Factsheet by Social Change Media prepared for WWF-Australia.

McKie, R. 2005. Puffins being wiped out as shrub chokes nesting sites. *The Observer* 18 December 2005.

Minton, C., 2003. The importance of long-term monitoring of reproductive rates in waders. *Wader Study Group Bulletin*. 100: 178-182.

Morrison, R. I. G., Gill, Jr., R. E., Harrington, B. A., Skagen, S., Page, G. W., Gratto-Trevor, C. L., and Haig, S. M. 2000. Population estimates of Nearctic shorebirds. *Waterbirds*, 23: 337-352.

Morrison, R. I. G, and Hicklin, P. 2001. Shorebird population trends and issues in Canada – an overview. *Bird Trends*, 8: 1-5.

NCHD. 2004. Living Coast Strategy for South Australia. Report by Natural and Cultural Heritage Department for Environment and Heritage for the Government of South Australia, Adelaide.

Oldland, J. M., Clemens, R. S., Haslem, A., Shelley, L. D., & Kearney, B. D. 2008. Final Report: Shorebirds 2020: Migratory Shorebird Population Monitoring Project. Report by Birds Australia for the Australian Government's Department of Environment, Water, Heritage and the Arts.

Olsen, P., M. Weston, R. Cunningham, and A. Silcocks. 2003. The State of Australia's Birds 2003. Supplement to Wingspan 13(4): 23pp.

Olsen, P., and M. Weston. 2004. The State of Australia's Birds 2004, Water, Wetlands, and Birds. Supplement to Wingspan 14(4): 23pp.

Park, P. 1994. Hooded Plovers and Marram Grass. *Stilt*. 25: 22pp

Paton, D. C., Ziembicki, M., Owen, P., & Heddle, C. 2000. Disturbance distances for water birds and the management of human recreation with special reference to the Coorong region of South Australia (abstract only). *Stilt* 37: 46.

Pfister, C., Harrington, B. A., & Lavine, M. 1992. The impact of human disturbance on shorebirds at a migration staging area. *Biological Conservation* 60: 115–126.

Peters, K. & Otis, L. 2007. Shorebird roost-site selection at two temporal scales: is human disturbance a factor? *Journal of Applied Ecology* 44: 196–209.

Pearce-Higgins, J.W. 2001. A model describing the exchange of individuals between turnstone *Arenaria interpres* roosts on the North Wales coast. *Ringing & Migration* 20: 209–212.

Rehfisch, M., Clark, N., Langston, R.. & Greenwood, J. 1996. A guide to the provision of refuges for waders: an analysis of 30 years of ringing data from the Wash, England. *Journal of Applied Ecology* 33: 673–687.

Rudman T. 2003. *Tasmanian Beach Weed Strategy for Marram Grass, Sea Spurge, Sea Wheatgrass, Pyp Grass and Beach Daisy*. Nature Conservation Report 03/2, Nature Conservation Branch, Department of Primary Industries, Water and Environment, Hobart.

Saintilan, N. & Williams, R. 1999. Mangrove transgression into saltmarsh environments in eastern Australia. Global Ecology and Biogeography, vol.8, pp.117–24 6.3 6.6

Saintilan, N. & Williams, R.J. 2000, 'The decline of saltmarshes in southeast Australia: Results of recent survey', Wetlands (Australia), vol.18, pp.49–54 6.6

Schlacher, T., Richardson, D., & McLean, I. 2008. Impacts of off-road vehicles (orvs) on macrobenthic assemblages on sandy beaches. *Environmental Management* 41: 878–892.

Straw, P., & Saintilan, N. 2006. Loss of shorebird habitat as a result of mangrove incursion due to sea-level rise and urbanization. In: G.C. Boere, C.A. Galbraith & D.A. Stroud (Eds) *Waterbirds Around the World*.. pp. 717–720.

Tubbs, C.R., Tubbs, J.M. & Kirby, J.S. (1992) Dunlin Calidrisalpina alpina in The Solent, southern England. *Biological Conservation*, 60, 15–24.

UNEP (2006) Marine and coastal ecosystems and human wellbeing :A synthesis report based on the findings of the Millennium Ecosystem Assessment. UNEP. 76pp

van Gils JA, T. Piersma, A. Dekinga, B. Spaans, and C. Kraan. 2006. Shellfish Dredging Pushes a Flexible Avian Top Predator out of a Marine Protected Area. PLoS Biol 4(12): e376

Veitch, C. R., & Clout, M. N. (Eds)(2002. Turning the Tide: The Eradication of Invasive Species. In: (Eds) *Proceedings of the International Conference on Eradication of Island Invasives*. IUCN, Gland, Switzerland and Cambridge, UK, pp. 254–259.

Watkins, D. 1993. *A National Plan for Shorebird Conservation in Australia*. RAOU Report 90.

Weston, M.A. 2000. *The Effect of Human Disturbance on the Breeding Biology of the Hooded Plover*. Unpublished PhD thesis, University of Melbourne, Melbourne.

Weston, M. A. 2003. *Managing the Hooded Plover in Victoria: a Review of Existing Information*. Parks Victoria Technical Series No. 4. Parks Victoria, Melbourne.

Wilcock, P.J. 1997. *Aspects of the Ecology of* Euphorbia paralias *L. (Sea Spurge) in Australia*. Unpublished Honours thesis, Centre for Environmental Management, University of Ballarat, Ballarat.

Wilson, J. 2000. The northward movement of immature Eastern Curlews in the Austral winter as demonstrated by the Population Monitoring Project. *Stilt* 36: 16-19.

WWF 2007. Shorebird Conservation Toolkit. http://www.shorebirds.org.au/International_sites.html

Appendix A. Maps of known important shorebird habitat in Gulf of Saint Vincent

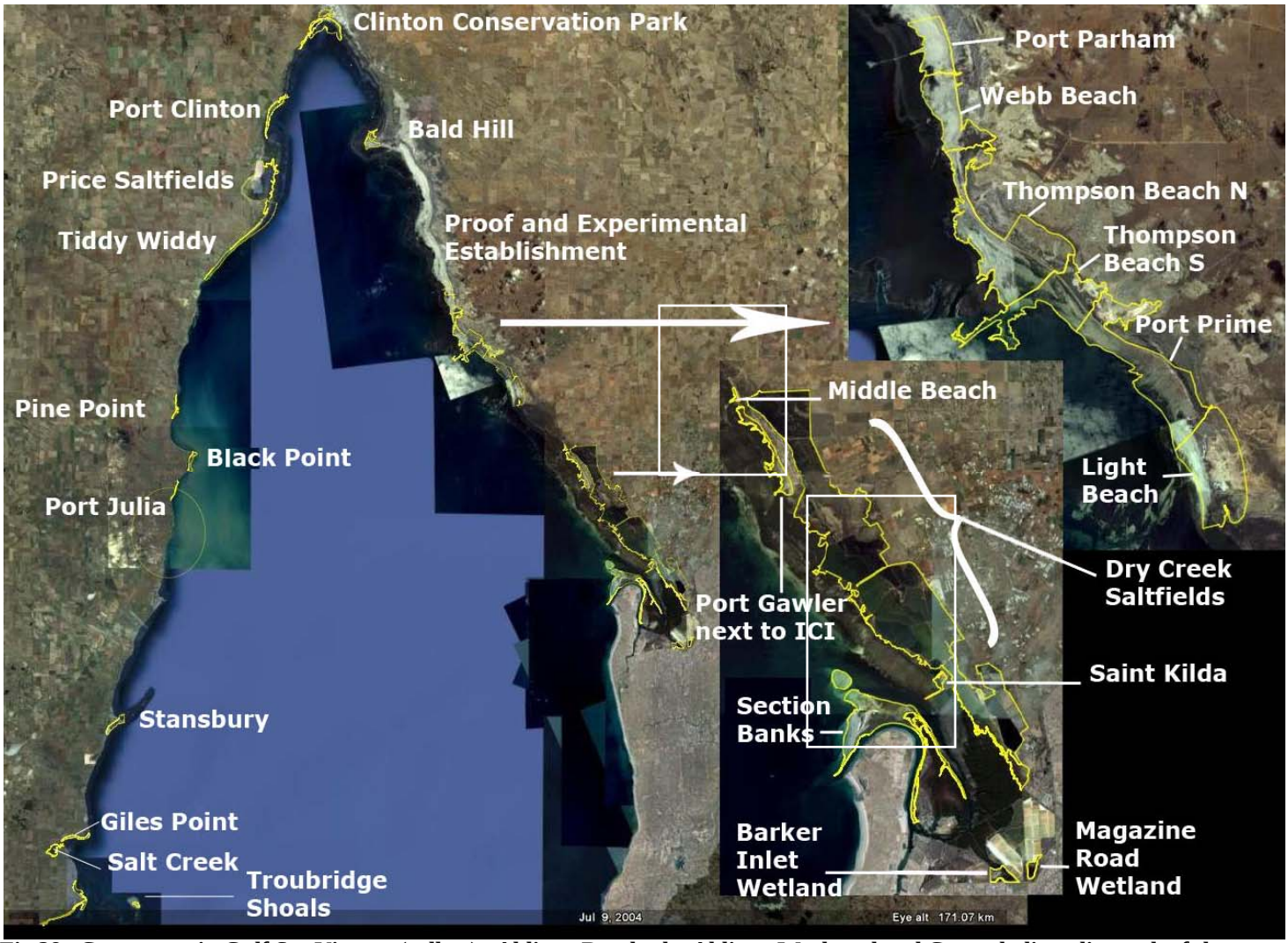

Fig 28. Count area in Gulf Snt Vincent (yellow). Aldinga Beach, the Aldinga Washpool and Carrackalinga lie south of the scope of this map.

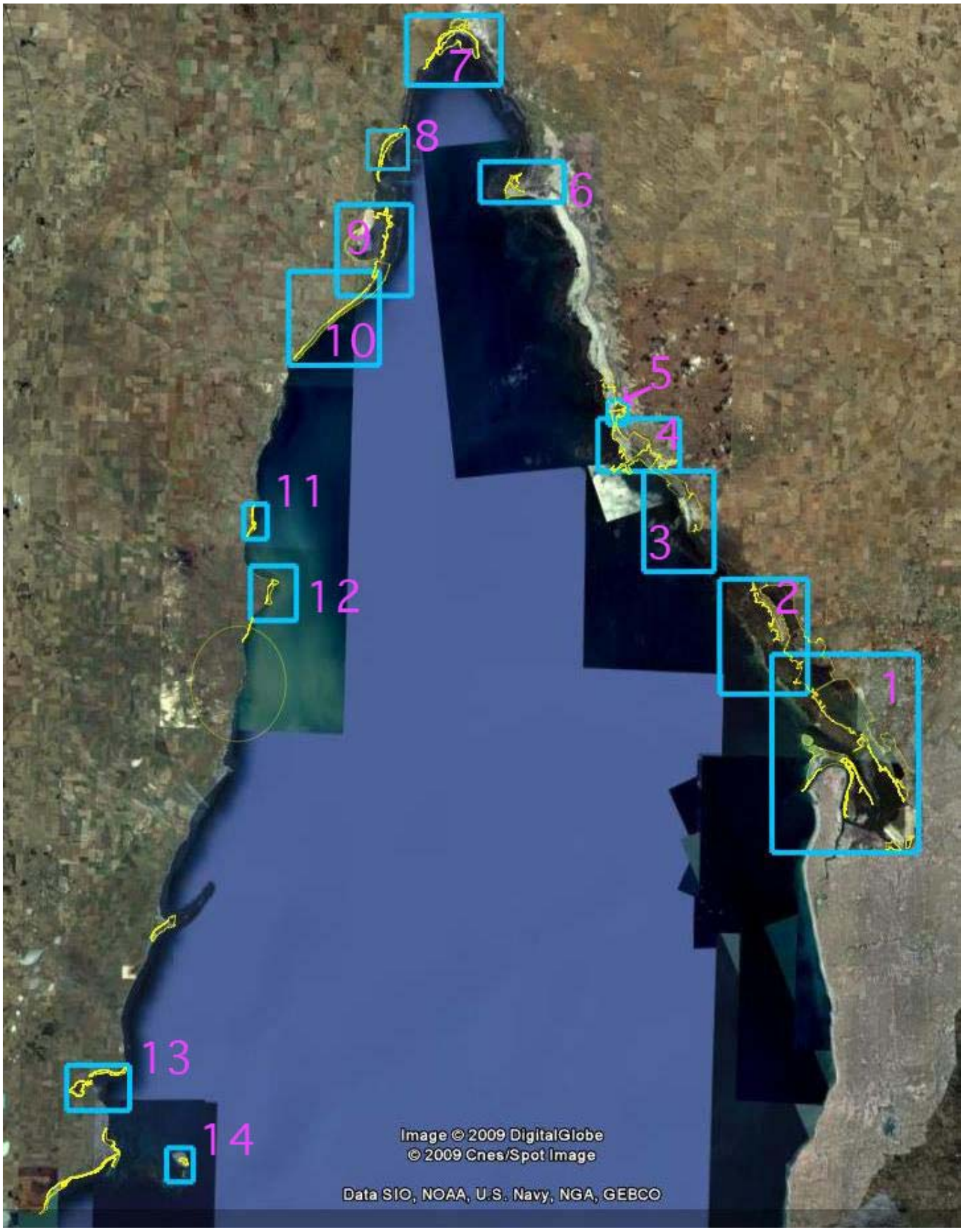

Fig 19. Index for locations of high resolution shorebird habitat images.

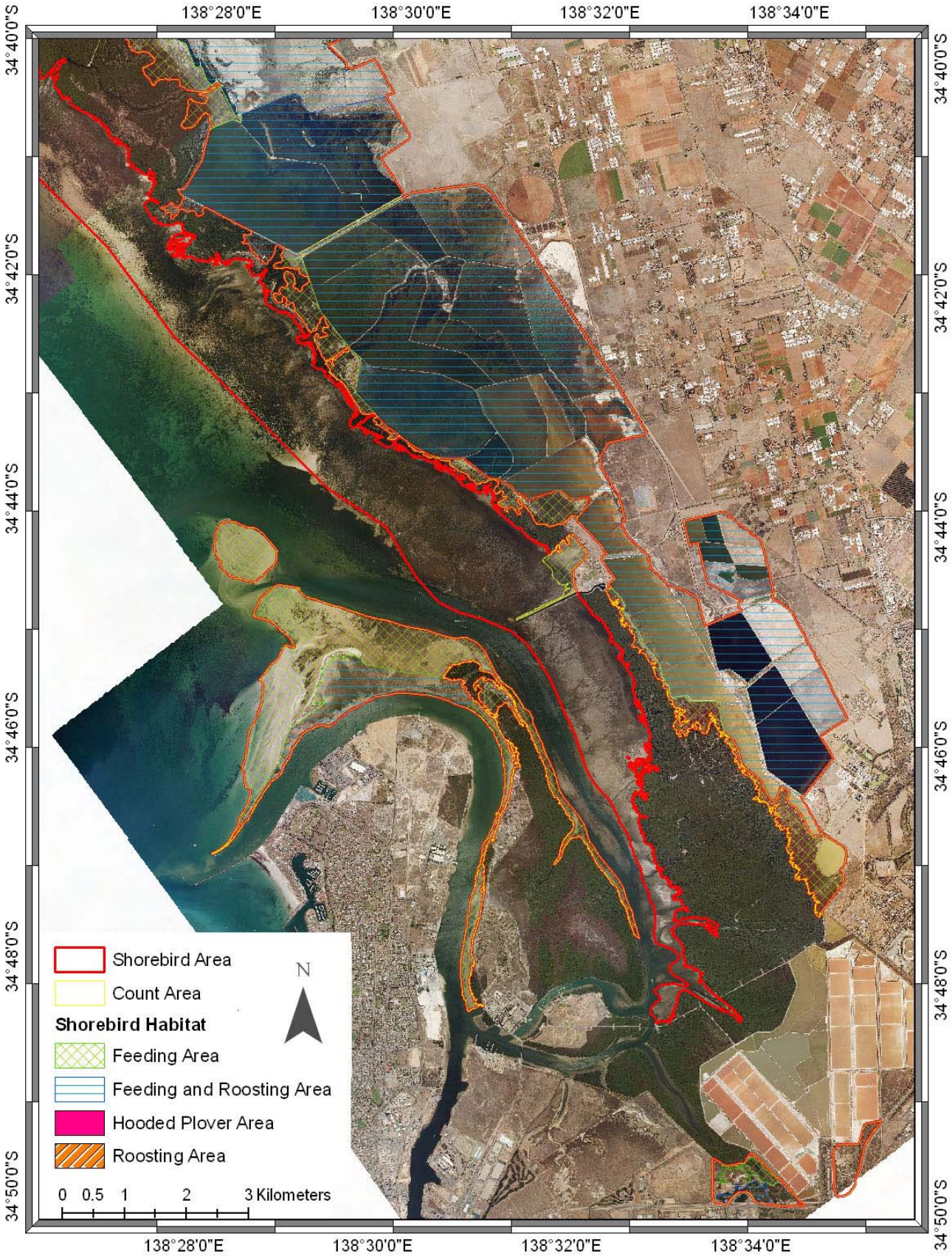

Fig 20. Shorebird habitat including Section Banks, Dry Creek saltfields, and Saint Kilda.

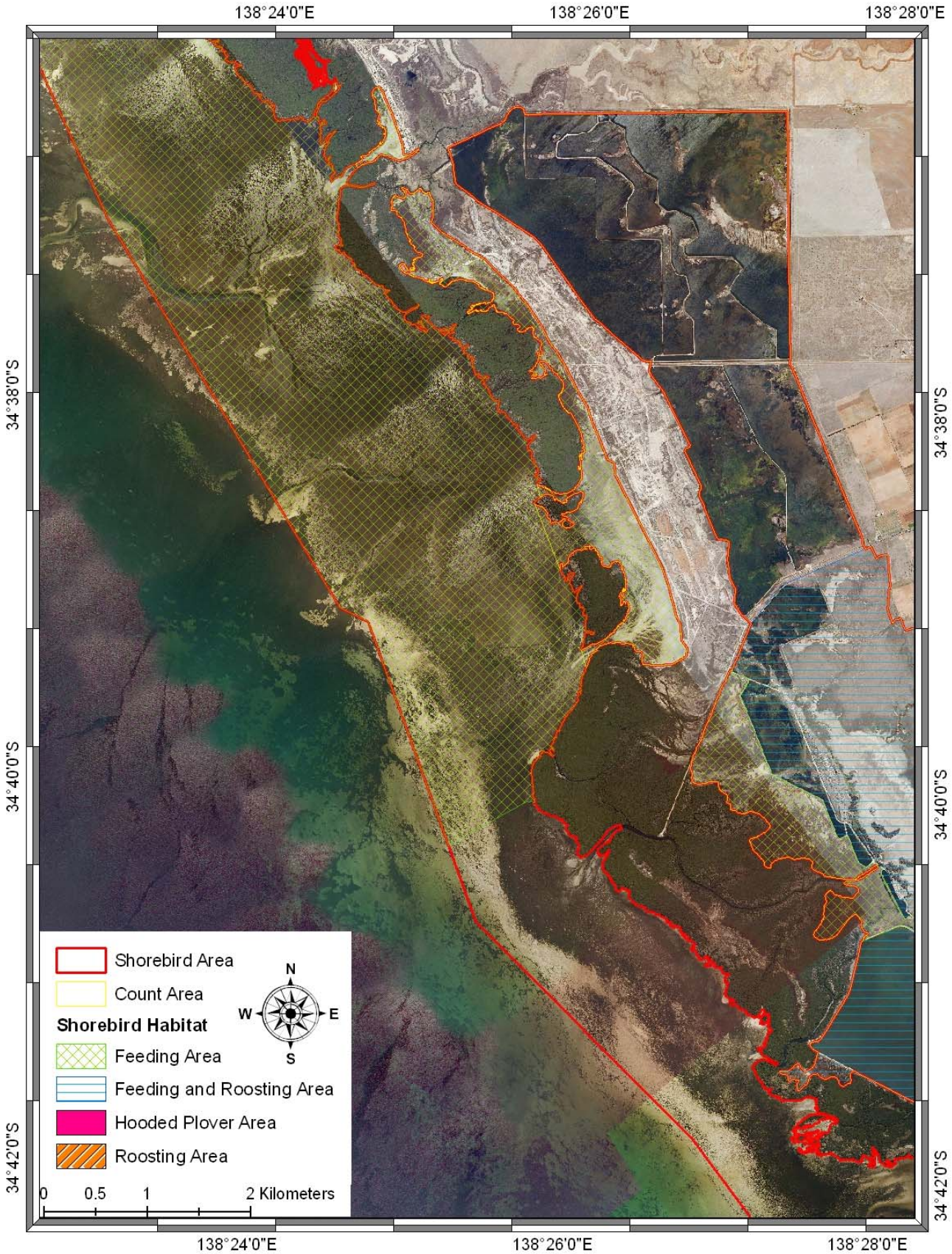

Fig 21. Shorebird habitat including the Port Gawler to Middle Beach area.

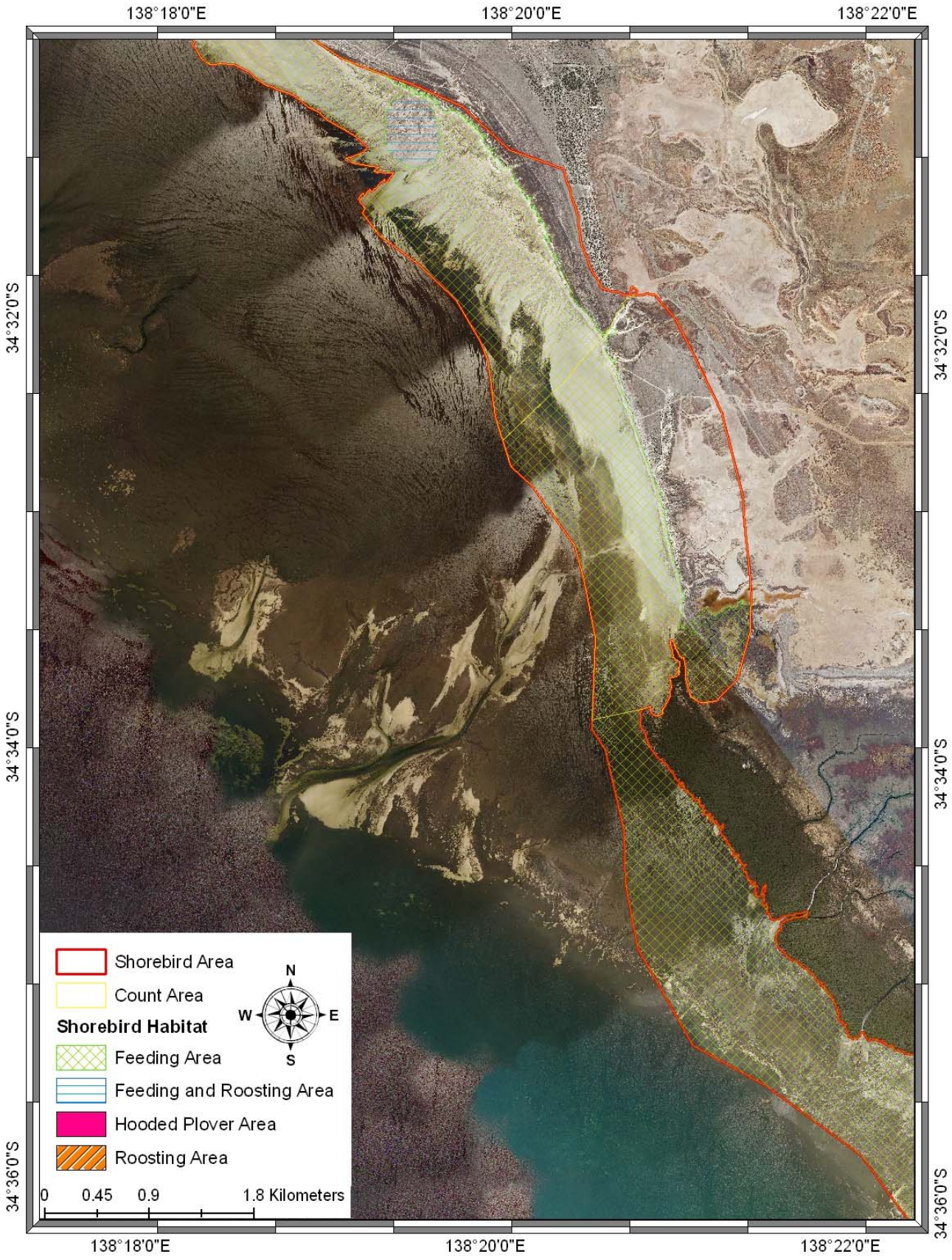

Fig 22. Shorebird habitat including Light Beach and Port Prime.

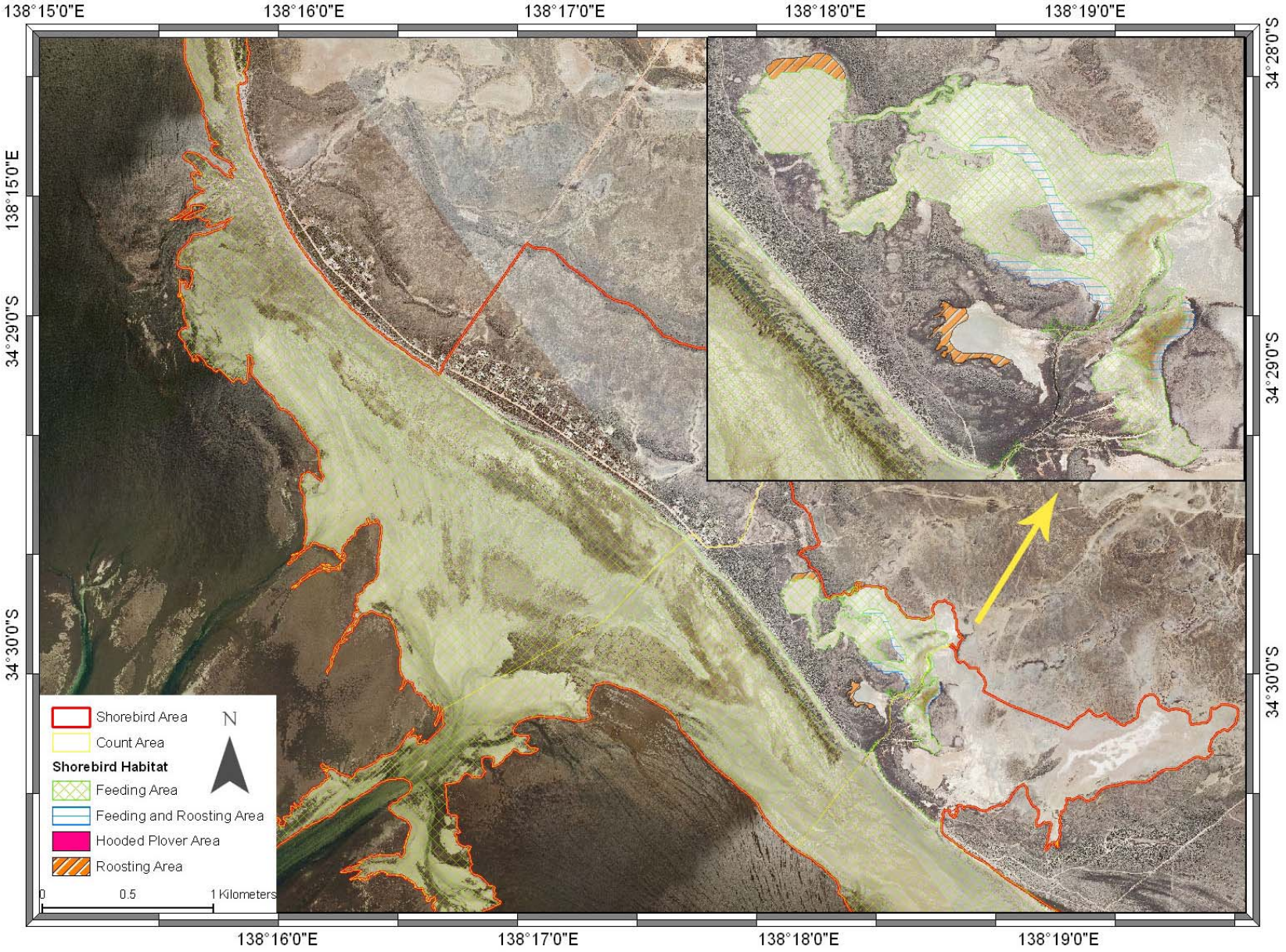

Fig 23. Shorebird habitat including the Third Creek subkah and Thompson Beach.

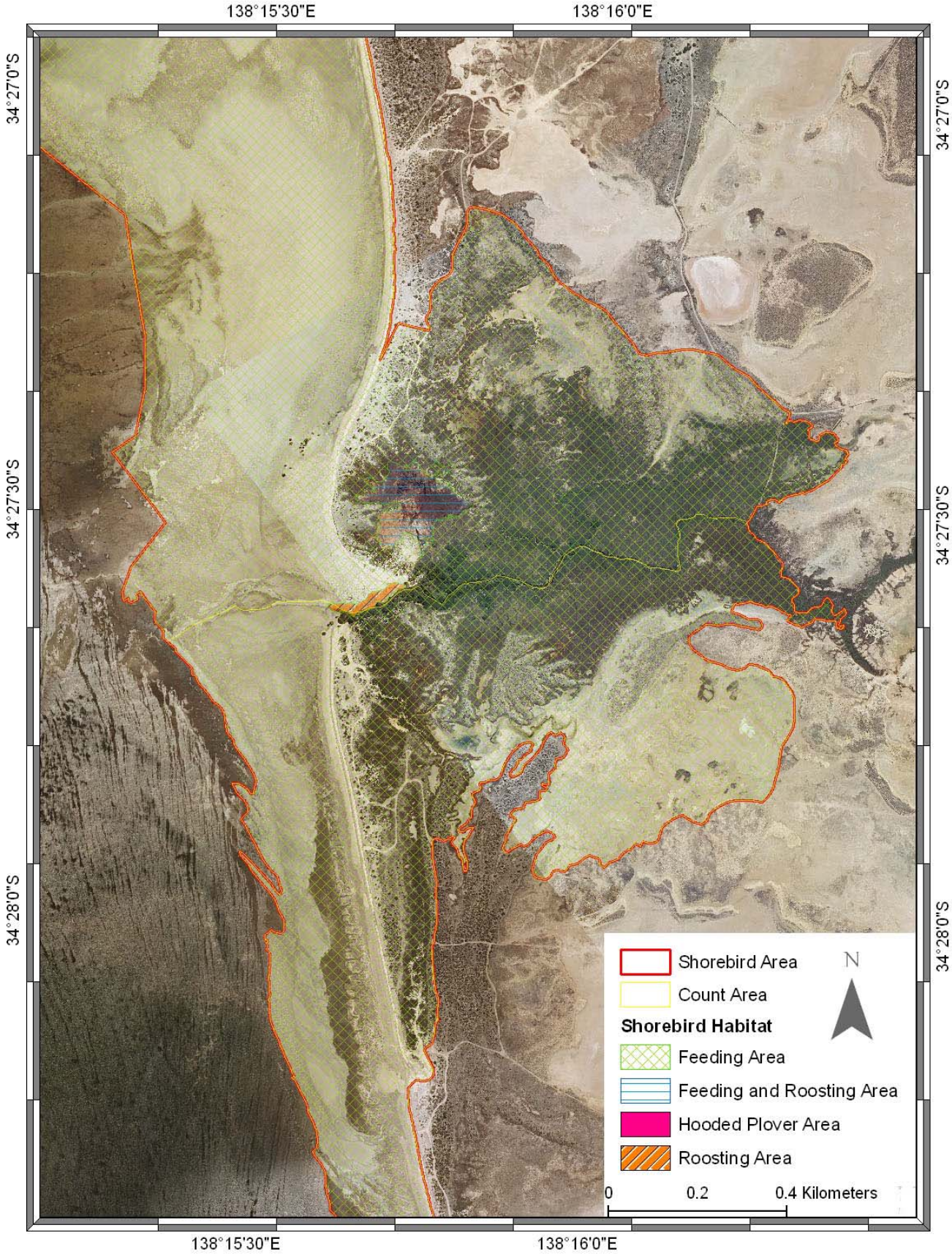

Fig24. Shorebird habitat including Bakers Creek and Webb Beach

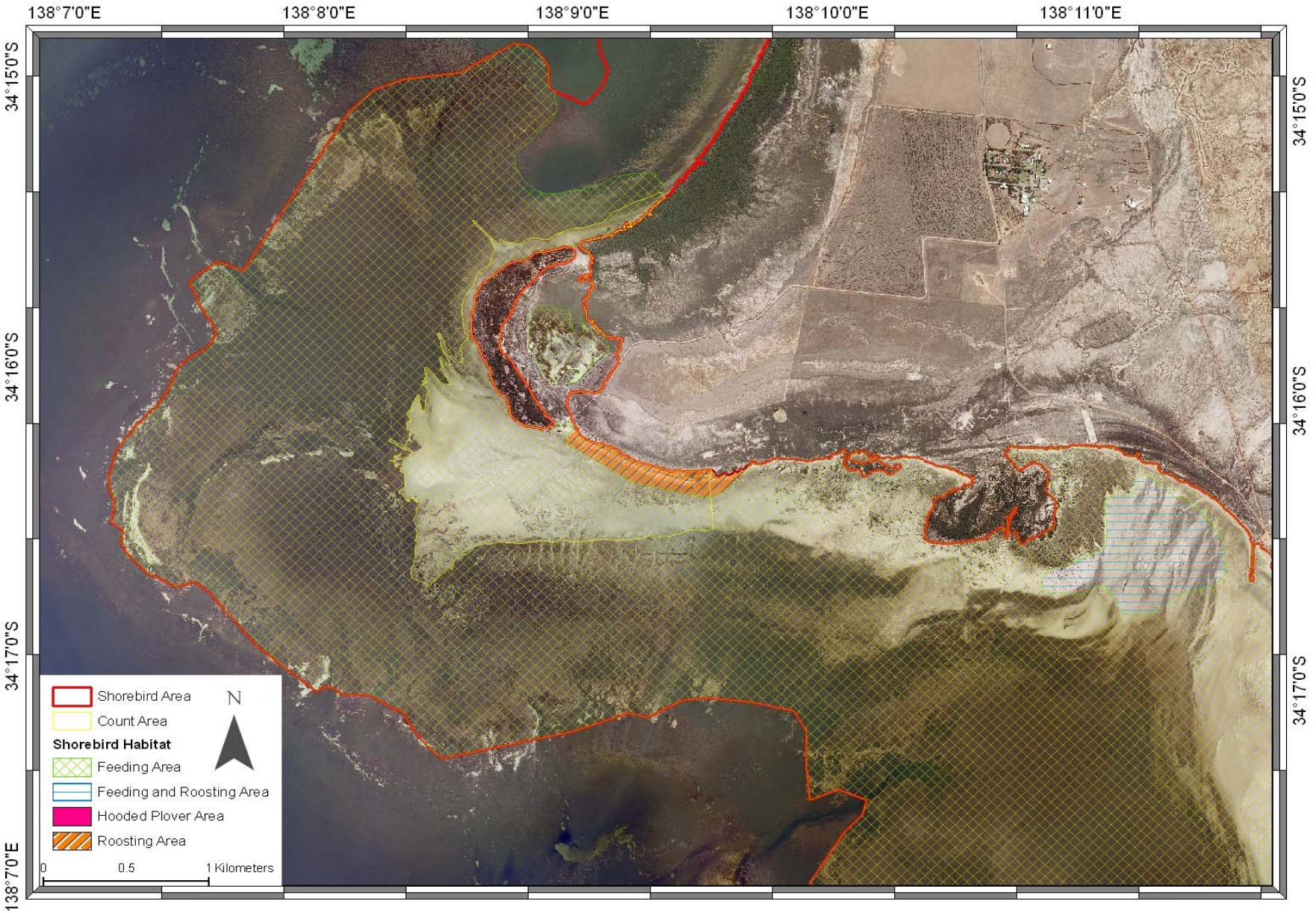

Fig25. Shorebird habitat including the northern limits of the Proof and Experimental Range and Bald Hill.

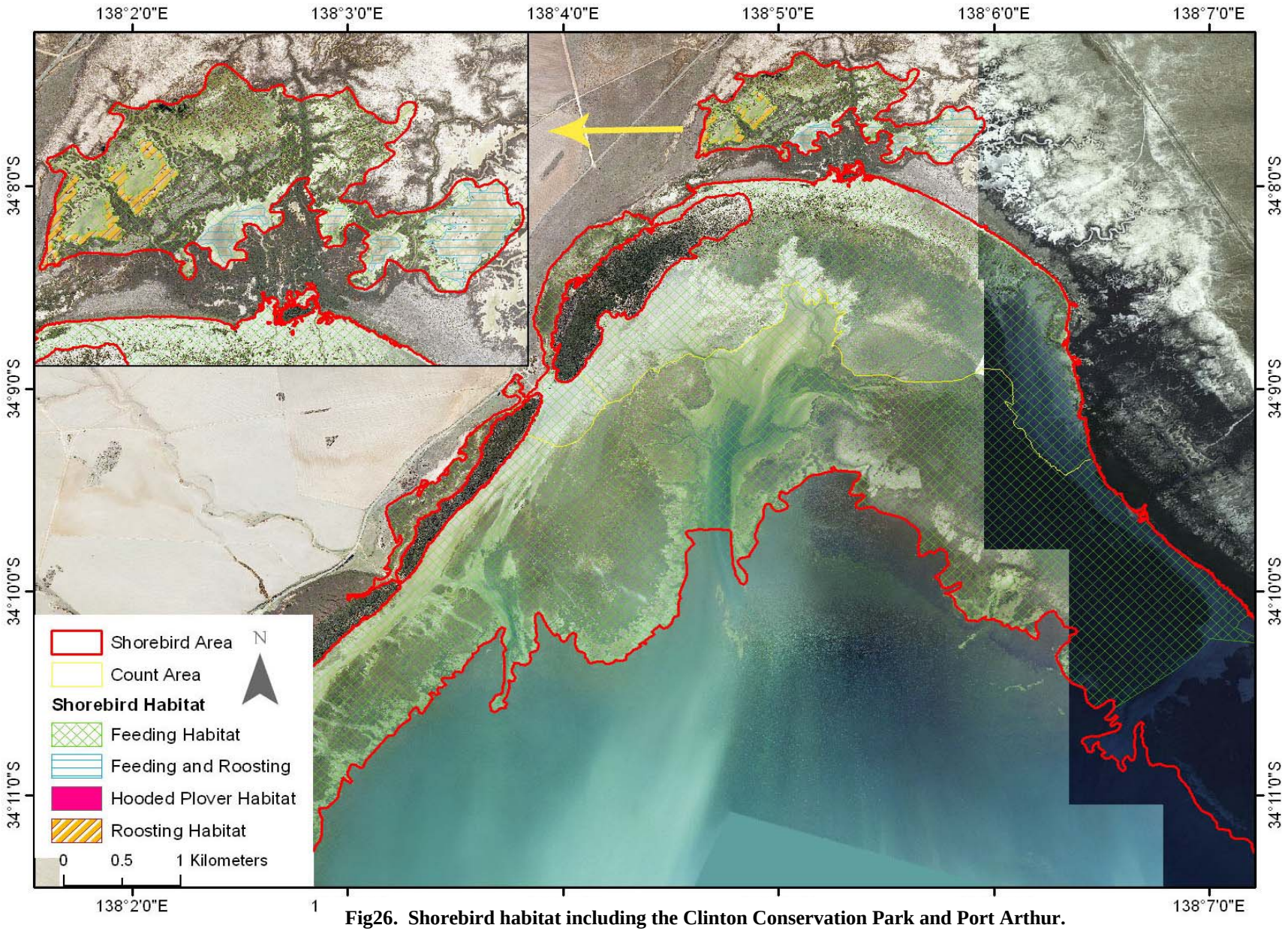

Fig26. Shorebird habitat including the Clinton Conservation Park and Port Arthur.

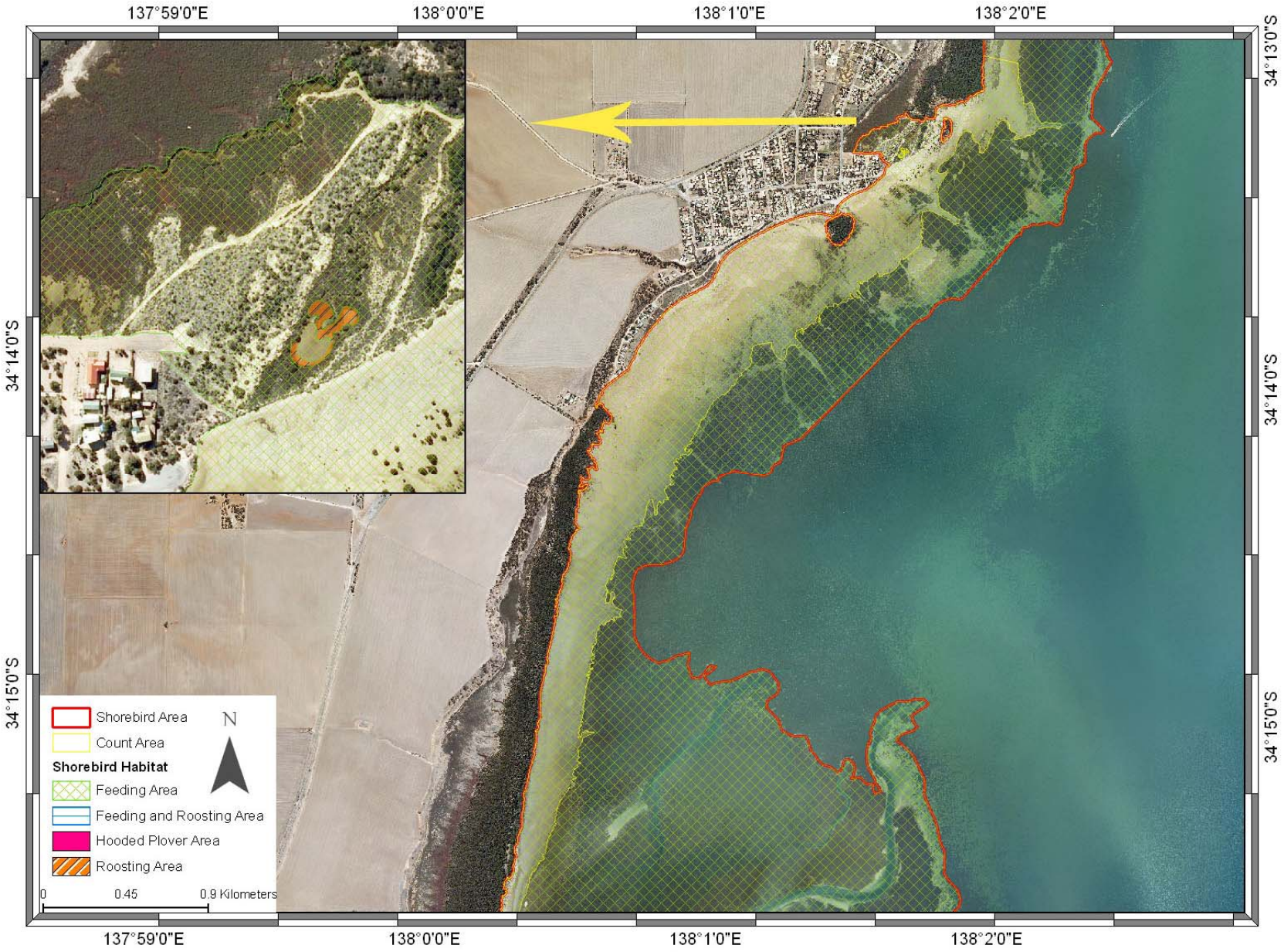

Fig 27. Shorebird habitat including Port Clinton.

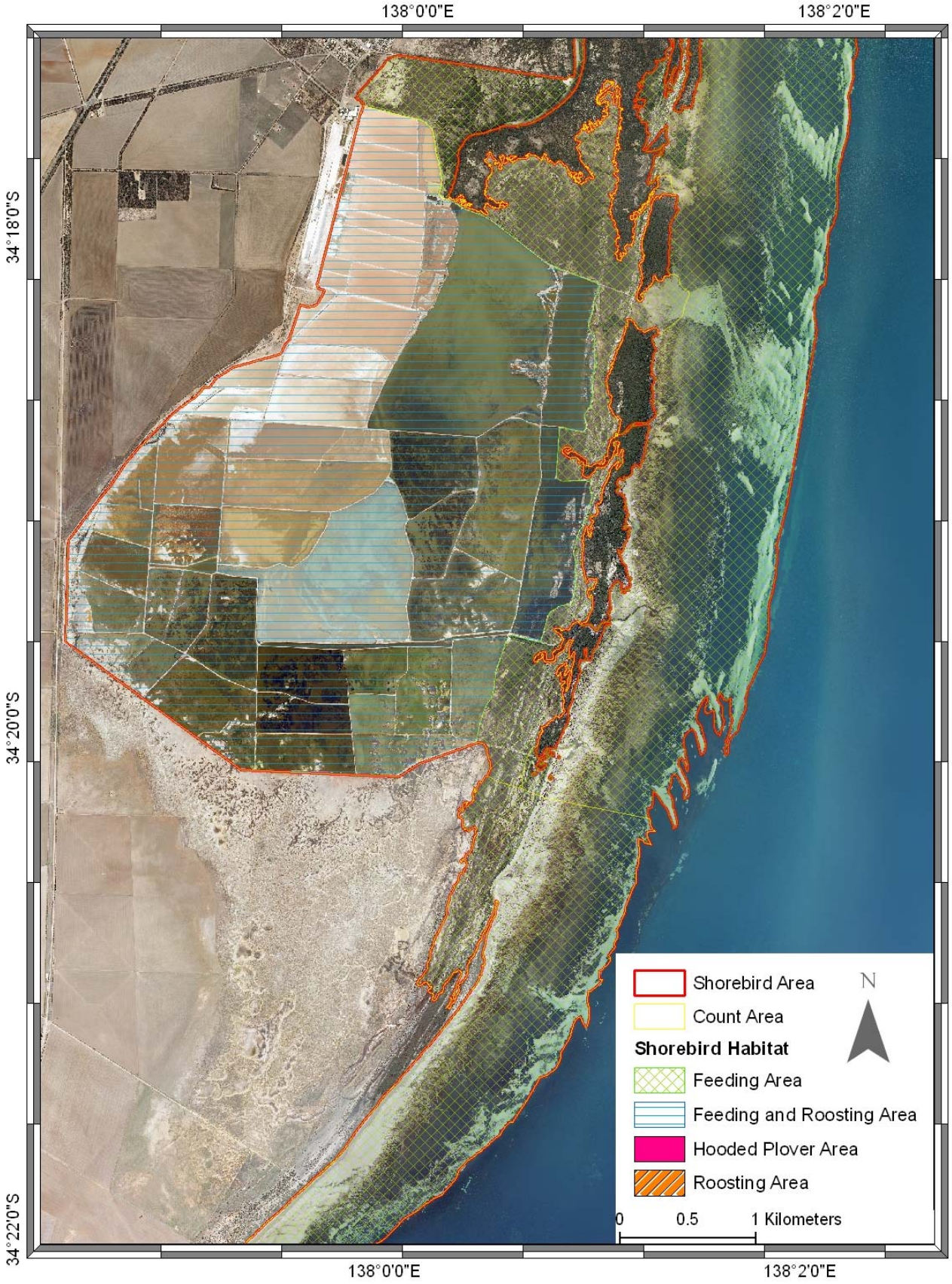

Fig 28. Shorebird habitat including Price Saltfeilds.

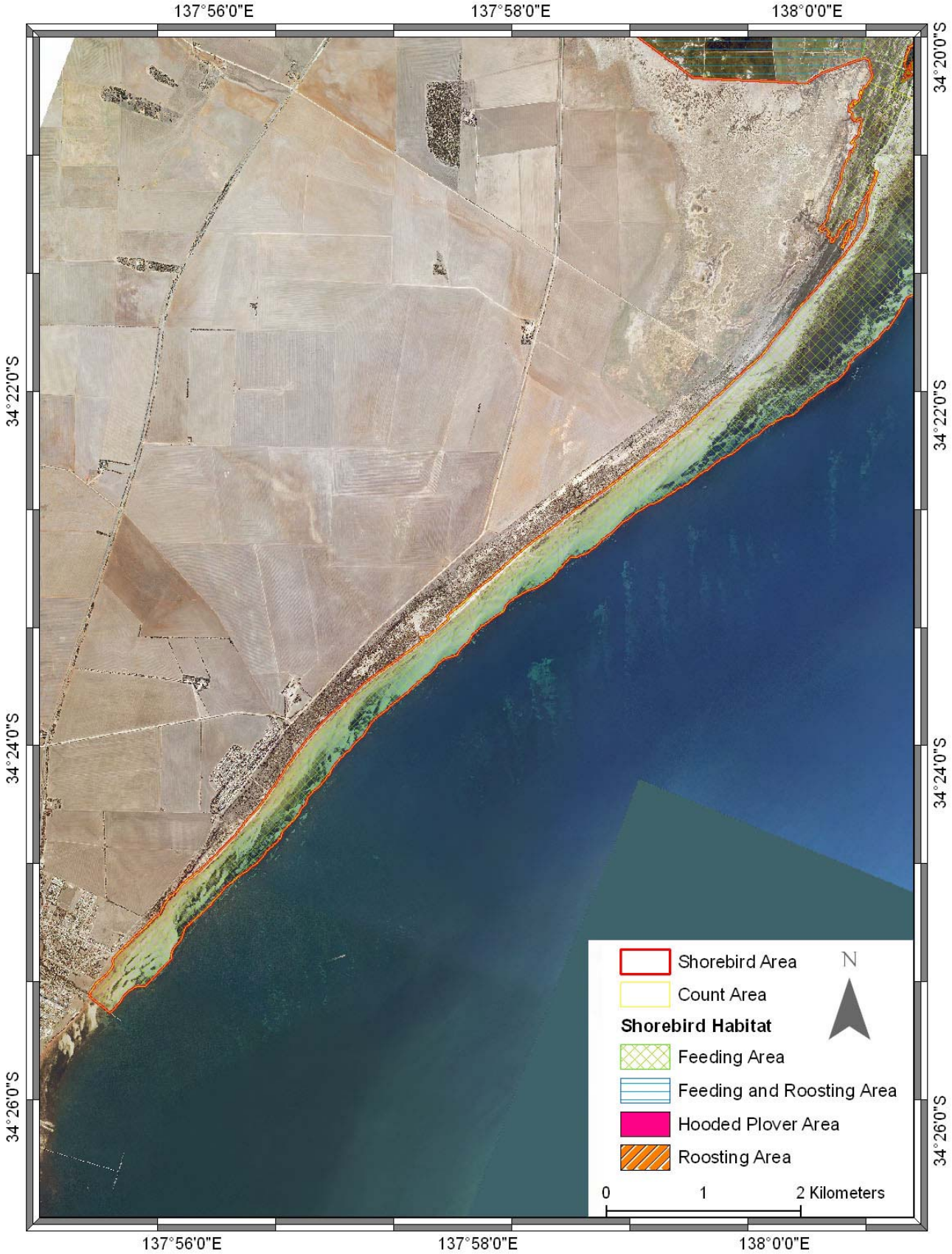

Fig 29. Shorebird habitat including coastline from Tiddy Widdy to Price Saltfeilds.

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Fig 30. Shorebird habitat including Pine Point.

Fig 31. Shorebird habitat including Black Point.

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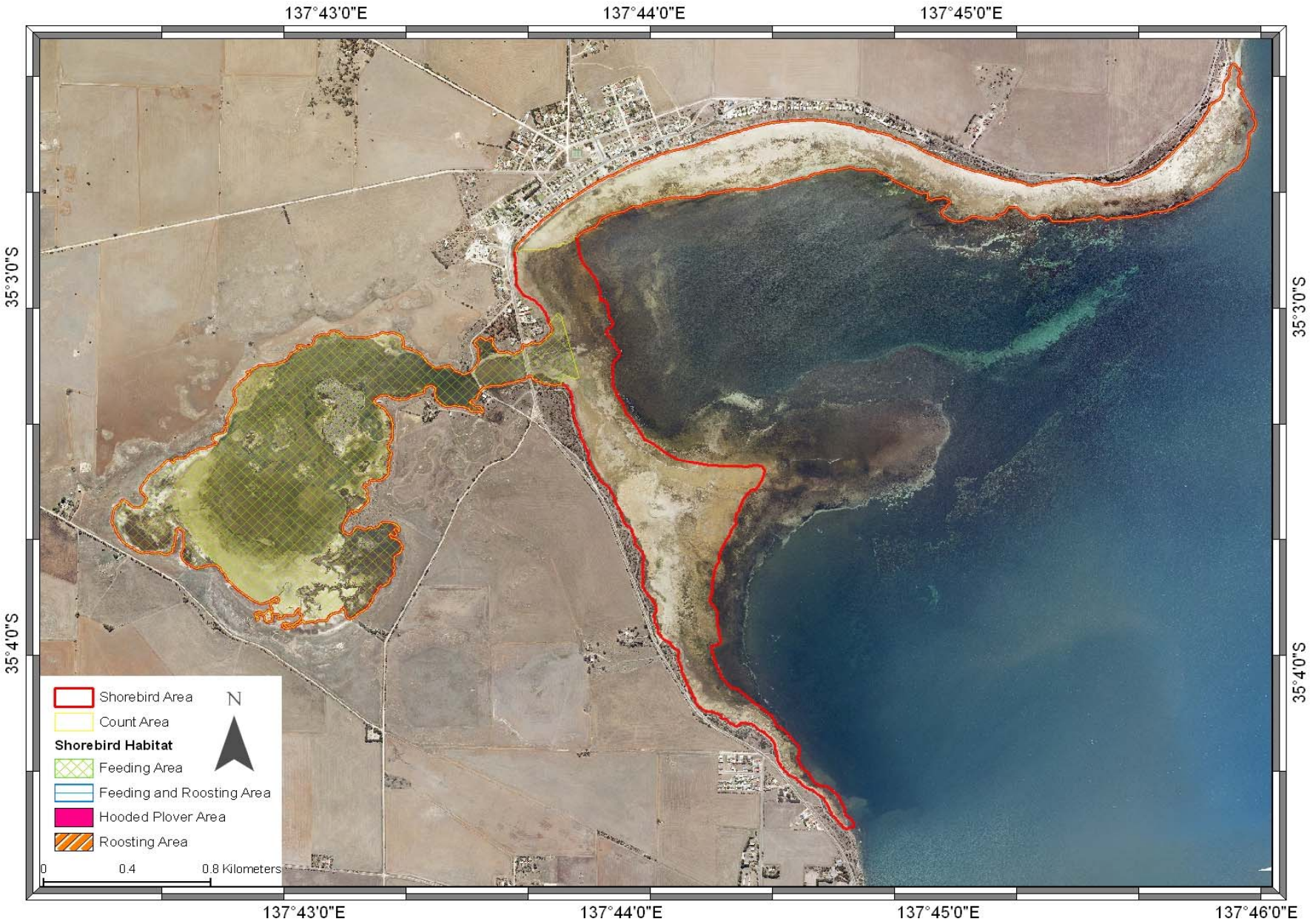

Fig 32. Shorebird habitat including Cooboowie Inlet and Giles Point.

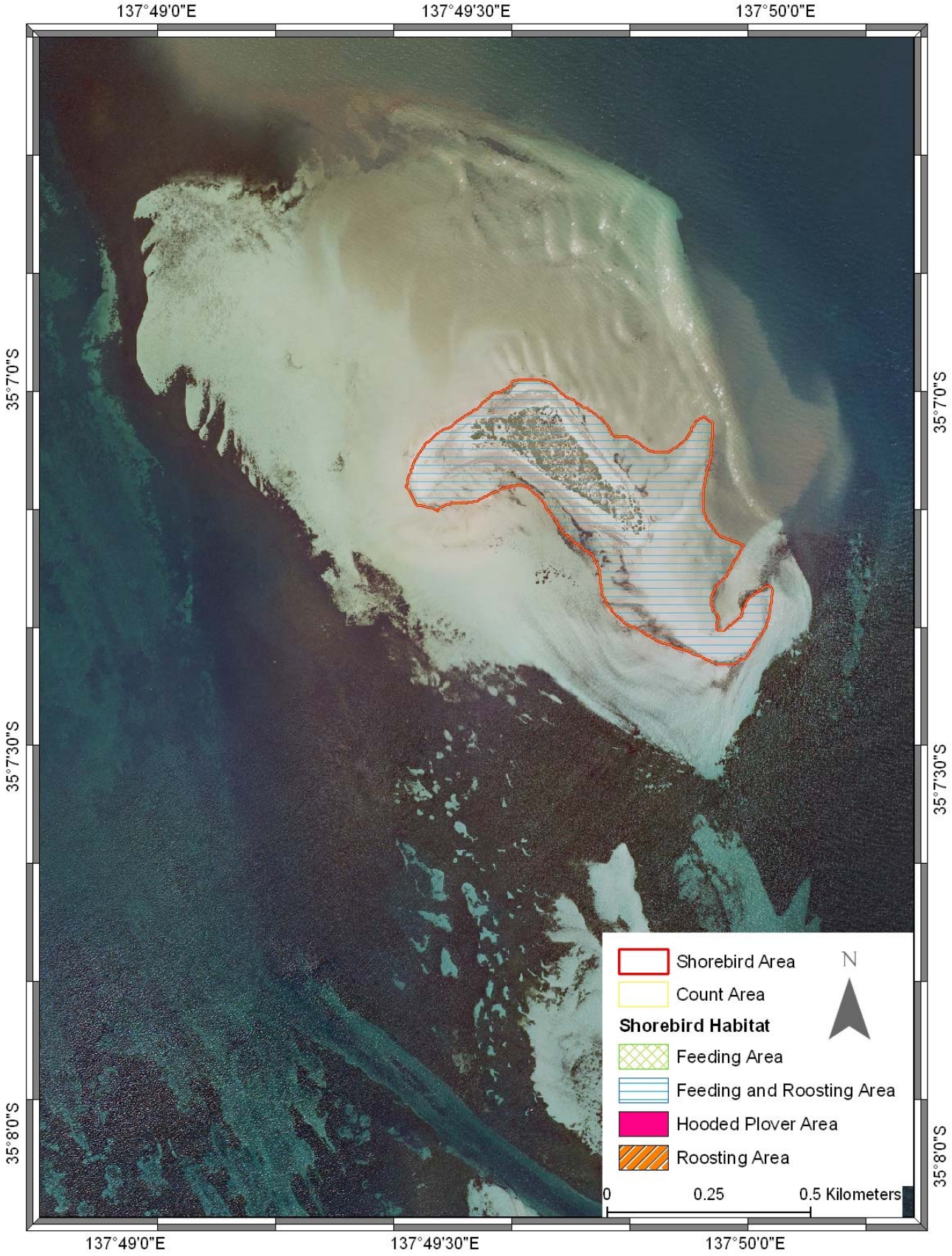

Fig 33. The shorebird habitat of Troubridge Shoals.

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Appendix B. Summary attributes of important shorebird areas in the Gulf of Saint Vincent (including # of shorebirds in each area)

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Table 3. Site codes for attribute tables.

SiteName	Aldinga Beach, (reef)	Aldinga Beach, (Washpool)	Bald Hill	Barker Inlet Wetlands	Black Point	Carrickaling a	Clinton Conservati on Park	Coobowie Inlet	Dry Creek Saltfields	Giles Point, Coobowie	Light Beach
Site code	Abr	Abw	BH	BIW	BP	Crka	CCP	CI	DCS	GPC	LB

SiteName	Magazine Road Wetlands	Middle Beach area	Pine Point	Port Arthur	Port Clinton	Port Gawler seafront next to ICI saltworks	Port Julia	Port Parham	Port Prime area	Port Wakefield	Port Wakefield proof and experiment al establishm ent
Site code	MRW	MB	PP	PA	PC	PG	PJ	PPhm	PPm	PW	PWEE

SiteName	Price Saltfields	Saint Kilda	Section Banks, Outer Harbour	Sheoak Beach	Stansbury	Thompson' s Beach	Thompson' s Beach North	Thompson' s Beach South	Tiddy Widdy - Price coast	Troubridge Shoal	Webb Beach
Site code	PSF	SK	Sboh	SB	Stby	TB	TBn	TBs	TW-Pr	TS	WB

Table 4. Maximum counts for shorebirds in the Gulf of Saint Vincent (1981-2009). Recently proposed national significance thresholds listed below; yellow for migratory waders, green for residents.

Site code	MaxOfBanded Lapwing	MaxOfBanded Stilt	MaxOfBar-tailed Godwit	MaxOfBlack-fronted Dotterel	MaxOfBlack-tailed Godwit	MaxOfBlack-winged Stilt	MaxOfCommon Greenshank	MaxOfCommon Sandpiper	MaxOfCurlew Sandpiper	MaxOfDouble-banded Plover	MaxOfEastern Curlew	MaxOfGreat Knot
Abr		0	0	0	0	0	0	0	0	0	0	0
Abw		0	0	0	0	28	2	0	0	0	0	0
BH		0	46	0	0	0	20	0	320	2	9	5
BIW		0	0	3	0	47	1	0	0	0	0	0
BP		0	0	0	0	0	22	17	350	78	2	0
Crka		0	0	0	0	0	0	0	0	0	0	0
CCP	1300	2500	200	0	0	12	295	0	2050	2	120	3
CI		6	0	0	0	0	99	1	237	9	5	0
DCS	6	29110	15	22	152	700	500	17	6256	30	95	60
GPC		0	0	0	0	0	2	0	48	0	0	0
LB	90	2	25	0	0	0	80	0	74	0	27	70
MRW		0	0	0	0	31	0	0	0	0	0	0
MB		20	0	0	0	0	52	3	15	0	0	0
PP		0	0	0	0	0	18	0	4	0	0	0
PA		0	0	0	0	0	5	0	0	0	1	0
PC	2	0	77	0	0	1	75	0	34	0	3	0
PG		1500	0	0	0	2	28	2	62	4	24	0
PJ		0	0	0	0	0	0	0	0	0	0	0
PPhm	76	0	210	0	2	2	180	10	180	7	3	20
PPm		300	335	0	1	0	125	6	600	0	10	100
PW		0	12	0	0	0	15	0	1000	0	100	0
PWEE	37	0	398	0	0	1	186	0	1300	0	5	0
PSF	9	15400	1324	2	35	320	594	3	3103	100	59	1908
SK		0	0	0	0	5	44	0	49	0	0	0
Sboh		0	0	0	0	0	8	1	350	0	21	0
SB		0	0	0	0	0	5	0	0	0	0	0
Stby		0	0	0	0	0	30	0	34	0	0	0
TB		0	1150	0	2	5	85	0	5	0	5	370
TBn		0	43	0	0	0	23	0	5	0	0	0
TBs		0	120	0	0	0	93	0	13	0	0	0
TW-Pr		0	1	0	0	0	8	0	105	0	0	0
TS		0	0	0	0	0	2	0	150	0	0	7
WB		0	7	0	0	0	50	0	39	0	0	1
	270	2060	325	170	160	2660	60	100	180	50	38	375

Site code	MaxOfGrey Plover	MaxOfGreater Sandplover	MaxOfGrey-tailed Tattler	MaxOfHooded Plover	MaxOfLesser Sandplover	MaxOfMarsh Sandpiper	MaxOfMasked Lapwing	MaxOfPacific Golden Plover	MaxOfPectoral Sandpiper	MaxOfPied Oystercatcher	MaxOfRed Knot	MaxOfRed-capped Plover
Abr	0	0	0	0	0	0	0	0		0	0	0
Abw	0	0	0	0	0	0	34	0		0	0	0
BH	0	51	18	0	0	0	29	8		0	100	800
BIW	0	0	0	0	0	6	5	0		0	0	22
BP	3	4	1	5	2	15	6	11		1	0	667
Crka	0	0	0	0	0	0	0	0		0	0	0
CCP	14	300	1	0	25	1	7	3	2	2	700	1282
CI	0	71	0	0	0	0	35	0		17	0	136
DCS	0	75	1	0	0	90	280	5	2	31	205	2380
GPC	0	1	0	2	0	0	10	0		3	0	20
LB	0	50	0	0	0	0	9	0		14	2500	1000
MRW	0	0	0	0	0	5	4	0		0	0	9
MB	0	0	38	0	1	1	2	4		3	0	25
PP	0	0	0	0	0	0	0	0		0	0	150
PA	0	0	0	0	0	0	2	0		2	0	25
PC	0	20	4	0	1	0	0	0		22	40	66
PG	0	47	0	0	3	6	9	0		3	1	540
PJ	0	0	0	5	0	0	0	0		0	0	12
PPhm	1	100	0	0	6	70	12	5		2	750	430
PPm	2	250	0	0	0	10	36	2		4	1000	485
PW	14	60	0	0	0	0	2	1		0	0	10
PWEE	0	458	0	2	2	0	12	0		2	0	370
PSF	12	444	14	0	16	84	32	32	1	22	2000	1200
SK	0	0	0	0	0	0	6	0		0	0	306
Sboh	0	1	0	0	0	0	7	0		120	0	1140
SB	0	0	0	0	0	0	0	2		2	0	50
Stby	0	0	0	0	0	0	2	0		0	0	0
TB	20	50	0	0	4	1	5	0		2	1300	270
TBn	0	18	0	0	0	0	2	0		0	175	254
TBs	0	20	0	0	0	0	7	0		0	0	353
TW-Pr	0	14	0	0	0	0	0	17		2	0	425
TS	0	20	0	0	0	0	0	0		9	48	20
WB	7	13	0	0	6	2	3	0		0	0	76
	110	125	50	50	140	1000	2870	100	100	110	220	950

Site code	MaxOfRed-kneed Dotterel	MaxOfRed-necked Avocet	MaxOfRed-necked Stint	MaxOfRuddy Turnstone	MaxOfSanderling	MaxOfSharp-tailed Sandpiper	MaxOfSooty Oystercatcher	MaxOfTerek Sandpiper	MaxOfWhimbrel	MaxOfWood Sandpiper
Abr	0	0	100	0	0	0	0	0	0	
Abw	0	0	0	0	0	121	0	0	0	
BH	0	0	894	22	0	550	1	0	0	
BIW	46	0	6	0	0	8	0	0	0	1
BP	0	0	1070	42	0	3	15	0	0	
Crka	0	0	0	0	0	0	0	0	0	
CCP	9	31	4541	9	0	3530	0	4	3	
CI	0	696	770	13	0	654	0	0	0	
DCS	346	1240	16400	15	0	9800	0	4	11	20
GPC	0	0	30	2	0	5	2	0	0	
LB	0	0	1200	0	0	3	0	0	0	
MRW	20	0	60	0	0	280	0	0	0	1
MB	7	0	500	0	0	500	0	0	0	
PP	0	0	310	0	0	0	2	0	0	
PA	0	0	40	0	0	3	0	0	0	
PC	30	0	215	20	0	44	0	0	0	
PG	9	0	770	8	0	155	0	0	0	
PJ	0	0	7	0	0	0	7	0	0	
PPhm	0	3	1440	10	0	334	0	0	31	
PPm	40	0	3000	23	0	1234	0	0	19	
PW	0	0	3000	0	0	1500	0	2	0	
PWEE	0	0	3790	64	0	2630	0	0	0	
PSF	27	1157	4305	451	0	2880	0	6	70	2
SK	0	0	782	0	0	481	0	0	0	
Sboh	0	0	4700	0	0	800	206	1	20	
SB	0	0	200	19	0	0	3	0		
Stby	0	0	250	14	0	30	18	0	0	
TB	0	0	3000	60	0	150	0	0	0	
TBn	0	0	346	12	0	51	0	0	0	
TBs	0	0	1153	4	0	13	0	0	0	
TW-Pr	0	0	1989	16	0	72	1	0	1	
TS	0	0	800	57	3	20	11	0	0	
WB	0	0	220	14	0	61	0	0	0	
	260	1070	325	35	22	160	40	60	100	1000

Table 5 Maximum counts of shorebird species from 1985-2005.

Species	Shorebird area	year	count
MaxOfBanded Lapwing	Clinton Conservation Park	1985	1300
MaxOfBanded Stilt	Dry Creek Saltfields	1986	29110
MaxOfBar-tailed Godwit	Price Saltfields	1996	846
MaxOfBlack-fronted Dotterel	Dry Creek Saltfields	1985	6
MaxOfBlack-tailed Godwit	Dry Creek Saltfields	1987	152
MaxOfBlack-winged Stilt	Dry Creek Saltfields	1989	470
MaxOfCommon Greenshank	Price Saltfields	1995	594
MaxOfCommon Sandpiper	Port Parham	1987	10
MaxOfCurlew Sandpiper	Dry Creek Saltfields	1986	3250
MaxOfDouble-banded Plover	Dry Creek Saltfields	1988	26
MaxOfEastern Curlew	Clinton Conservation Park	1985	120
MaxOfGreat Knot	Price Saltfields	1990	1908
MaxOfGrey Plover	Port Prime area	1989	250
MaxOfGreater Sandplover	Clinton Conservation Park	1986	14
MaxOfGrey-tailed Tattler	Price Saltfields	1987	14
MaxOfHooded Plover			0
MaxOfLesser Sandplover	Clinton Conservation Park	1985	16
MaxOfMarsh Sandpiper	Price Saltfields	1995	84
MaxOfMasked Lapwing	Dry Creek Saltfields	1987	211
MaxOfPacific Golden Plover	Clinton Conservation Park	1995	3
MaxOfPectoral Sandpiper	Clinton Conservation Park	1989	2
MaxOfPied Oystercatcher	Dry Creek Saltfields	1985	31
MaxOfRed Knot	Price Saltfields	2000	1400
MaxOfRed-capped Plover	Dry Creek Saltfields	1986	2380
MaxOfRed-kneed Dotterel	Dry Creek Saltfields	1985	346
MaxOfRed-necked Avocet	Dry Creek Saltfields	1986	1240
MaxOfRed-necked Stint	Dry Creek Saltfields	1986	16400
MaxOfRuddy Turnstone	Price Saltfields	2001	451
MaxOfSanderling			0
MaxOfSharp-tailed Sandpiper	Dry Creek Saltfields	1989	6200
MaxOfSooty Oystercatcher			0
MaxOfTerek Sandpiper	Price Saltfields	1990	6
MaxOfWhimbrel	Price Saltfields	1986	70
MaxOfWood Sandpiper	Dry Creek Saltfields	1987	8

Table 6. Average species counts for shorebird areas in the Gulf of Saint Vincent. Average total shorbirds by site in blue, number of species observed by site in yellow

Site code	Banded Lapwing	Banded Stilt	Bar-tailed Godwit	Black-fronted Dotterel	Black-tailed Godwit	Black-winged Stilt	Common Greenshank	Common Sandpiper	Curlew Sandpiper	Double-banded Plover	Eastern Curlew	Great Knot	Greater Sandplover
Abr		0	0	0	0	0	0	0	0	0	0	0	0
Abw		0	0	0	0	28	2	0	0	0	0	0	0
BH		0	16	0	0	0	14	0	107	1	7	3	0
BIW		0	0	3	0	47	1	0	0	0	0	0	0
BP		0	0	0	0	0	16	3	78	17	0	0	1
Crka		0	0	0	0	0	0	0	0	0	0	0	0
CCP	417	622	64	0	0	3	90	0	804	0	75	0	2
CI		3	0	0	0	0	54	0	81	3	2	0	0
DCS	4	6931	1	2	46	269	235	4	1485	10	24	4	0
GPC		0	0	0	0	0	2	0	48	0	0	0	0
LB	90	2	25	0	0	0	80	0	74	0	27	70	0
MRW		0	0	0	0	31	0	0	0	0	0	0	0
MB		7	0	0	0	0	32	1	5	0	0	0	0
PP		0	0	0	0	0	18	0	4	0	0	0	0
PA		0	0	0	0	0	5	0	0	0	1	0	0
PC	2	0	39	0	0	1	48	0	18	0	2	0	0
PG		750	0	0	0	1	14	1	31	2	14	0	0
PJ		0	0	0	0	0	0	0	0	0	0	0	0
PPhm	76	0	66	0	0	0	54	3	85	1	1	4	0
PPm		53	160	0	0	0	60	1	142	0	4	25	1
PW		0	12	0	0	0	15	0	1000	0	100	0	14
PWEE	37	0	199	0	0	1	94	0	650	0	4	0	0
PSF	7	7446	519	0	6	74	192	1	1470	13	21	433	2
SK		0	0	0	0	5	44	0	49	0	0	0	0
Sboh		0	0	0	0	0	4	0	138	0	7	0	0
SB		0	0	0	0	0	3	0	0	0	0	0	0
Stby		0	0	0	0	0	21	0	32	0	0	0	0
TB		0	675	0	1	3	65	0	5	0	3	225	14
TBn		0	43	0	0	0	23	0	5	0	0	0	0
TBs		0	120	0	0	0	93	0	13	0	0	0	0
TW-Pr		0	1	0	0	0	8	0	105	0	0	0	0
TS		0	0	0	0	0	1	0	99	0	0	4	0
WB		0	7	0	0	0	50	0	39	0	0	1	7

Site code	Grey Plover	Grey-tailed Tattler	Hooded Plover	Lesser Sandplover	Marsh Sandpiper	Masked Lapwing	Pacific Golden Plover	Pectoral Sandpiper	Pied Oystercatcher	Red Knot	Red-capped Plover	Red-kneed Dotterel	Red-necked Avocet
Abr	0	0	0	0	0	0	0		0	0	0	0	0
Abw	0	0	0	0	0	34	0		0	0	0	0	0
BH	30	6	0	0	0	11	3		0	34	432	0	0
BIW	0	0	0	0	6	5	0		0	0	22	46	0
BP	1	0	1	0	3	2	4		0	0	160	0	0
Crka	0	0	0	0	0	0	0		0	0	0	0	0
CCP	116	0	0	6	0	2	1	2	0	58	352	2	3
CI	38	0	0	0	0	22	0		6	0	58	0	232
DCS	26	0	0	0	32	84	1	1	3	34	868	90	408
GPC	1	0	2	0	0	10	0		3	0	20	0	0
LB	50	0	0	0	0	9	0		14	2500	1000	0	0
MRW	0	0	0	0	5	4	0		0	0	9	20	0
MB	0	15	0	0	0	1	1		1	0	17	2	0
PP	0	0	0	0	0	0	0		0	0	150	0	0
PA	0	0	0	0	0	2	0		2	0	25	0	0
PC	10	2	0	1	0	0	0		11	20	35	15	0
PG	24	0	0	2	3	5	0		2	1	270	5	0
PJ	0	0	5	0	0	0	0		0	0	12	0	0
PPhm	48	0	0	2	25	5	1		0	134	168	0	1
PPm	108	0	0	0	2	8	0		1	176	248	6	0
PW	60	0	0	0	0	2	1		0	0	10	0	0
PWEE	229	0	1	1	0	7	0		1	0	200	0	0
PSF	151	2	0	3	29	14	3	1	10	663	330	7	407
SK	0	0	0	0	0	6	0		0	0	306	0	0
Sboh	1	0	0	0	0	4	0		52	0	522	0	0
SB	0	0	0	0	0	0	1		2	0	25	0	0
Stby	0	0	0	0	0	1	0		0	0	0	0	0
TB	50	0	0	2	1	3	0		1	900	198	0	0
TBn	18	0	0	0	0	2	0		0	175	254	0	0
TBs	20	0	0	0	0	7	0		0	0	353	0	0
TW-Pr	14	0	0	0	0	0	17		2	0	425	0	0
TS	15	0	0	0	0	0	0		8	32	12	0	0
WB	13	0	0	6	2	3	0		0	0	76	0	0

Site code	Red-necked Stint	Ruddy Turnstone	Sanderling	Sharp-tailed Sandpiper	SumOfSooty Oystercatcher	Terek Sandpiper	Whimbrel	Wood Sandpiper	Average shorebirds per site	species per site
Abr	100	0	0	0	0	0	0		100	1
Abw	0	0	0	121	0	0	0		185	4
BH	565	11	0	308	0	0	0		1546	15
BIW	6	0	0	8	0	0	0	1	145	10
BP	585	25	0	1	6	0	0		905	19
Crka	0	0	0	0	0	0	0		0	0
CCP	2205	1	0	1109	0	1	0		5934	27
CI	293	6	0	245	0	0	0		1042	14
DCS	7484	5	0	3455	0	0	2	8	21515	28
GPC	30	2	0	5	2	0	0		125	11
LB	1200	0	0	3	0	0	0		5144	14
MRW	60	0	0	280	0	0	0	1	410	9
MB	178	0	0	177	0	0	0		437	14
PP	310	0	0	0	2	0	0		484	5
PA	40	0	0	3	0	0	0		78	7
PC	108	10	0	27	0	0	0		346	16
PG	385	4	0	78	0	0	0		1589	17
PJ	7	0	0	0	7	0	0		31	4
PPhm	807	6	0	95	0	0	5		1587	24
PPm	1500	7	0	348	0	0	5		2854	21
PW	3000	0	0	1500	0	2	0		5716	12
PWEE	1905	32	0	1323	0	0	0		4681	15
PSF	2294	138	0	1309	0	1	19	2	15565	31
SK	782	0	0	481	0	0	0		1673	7
Sboh	2659	0	0	322	129	0	7		3845	14
SB	100	10	0	0	2	0		0	142	7
Stby	207	7	0	18	15	0	0		299	8
TB	1588	55	0	113	0	0	0		3898	18
TBn	346	12	0	51	0	0	0		929	10
TBs	1153	4	0	13	0	0	0		1776	9
TW-Pr	1989	16	0	72	1	0	1		2651	12
TS	650	49	2	13	9	0	0		889	12
WB	220	14	0	61	0	0	0		499	13

Table 7. Totals of species observed during Gulf -wide counts on the 29/11/2008 and 28/2/2009. Highlited blue numbers represent significant counts in relation to national species populations.

Start Date	Banded Lapwing	Banded Stilt	Bar-tailed Godwit	Black-fronted Dotterel	Black-tailed Godwit	Black-winged Stilt	Common Greenshank	Common Sandpiper	Curlew Sandpiper	Double-banded Plover	Eastern Curlew	Great Knot
29-Nov-08		12062	419	25	0	358	189	1	239	0	9	930
28-Feb-09	90	3252	532	0	25	94	519	4	391	4	28	205

Start Date	Grey Plover	Greater Sandplover	Grey-tailed Tattler	Hooded Plover	Lesser Sandplover	Marsh Sandpiper	Masked Lapwing	Pacific Golden Plover	Pectoral Sandpiper	Pied Oystercatcher	Red Knot
29-Nov-08	175	2	1	2	7	35	154	5	1	32	1150
28-Feb-09	239	8	4	5	8	22	123	2		39	1675

Start Date	Red-capped Plover	Red-kneed Dotterel	Red-necked Avocet	Red-necked Stint	Ruddy Turnstone	Sanderling	Sharp-tailed Sandpiper	Sooty Oystercatcher	Terek Sandpiper	Whimbrel	Wood Sandpiper
29-Nov-08	658	152	555	9040	67	0	1384	2	0	6	2
28-Feb-09	2997	121	285	6243	87	0	1154	7	1	18	2

Table 8. Shorebirds observed by site on simultaneous Gulf wide counts of the 29/11/08 and 28/2/09 (total shorebirds by site in orange)

Start Date	Site Name	SumOfBanded Stilt	SumOfBar-tailed Godwit	SumOfBlack-fronted Dotterel	SumOfBlack-winged Stilt	SumOfCommon Greenshank	SumOfCommon Sandpiper	SumOfCurlew Sandpiper	SumOfEastern Curlew	SumOfGreat Knot	SumOfGrey Plover	SumOfGreater Sandplover
29-Nov-08	Abr	0	0	0	0	0	0	0	0	0	0	0
29-Nov-08	Abw	0	0	0	28	2	0	0	0	0	0	0
29-Nov-08	BIW	0	0	3	47	1	0	0	0	0	0	0
29-Nov-08	BP	0	0	0	0	0	0	0	0	0	0	0
29-Nov-08	Crka	0	0	0	0	0	0	0	0	0	0	0
29-Nov-08	CI	0	0	0	0	8	0	0	0	0	2	0
29-Nov-08	DCS	10062	0	22	239	75	1	108	0	0	42	0
29-Nov-08	GPC	0	0	0	0	0	0	10	0	0	1	0
29-Nov-08	MRW	0	0	0	31	0	0	0	0	0	0	0
29-Nov-08	MB	0	0	0	0	10	0	0	0	0	0	0
29-Nov-08	PA	0	0	0	0	2	0	0	1	0	0	0
29-Nov-08	PC	0	0	0	0	8	0	0	1	0	8	0
29-Nov-08	PG	0	0	0	2	5	0	0	4	0	47	0
29-Nov-08	PPhm	0	0	0	0	14	0	10	0	0	5	0
29-Nov-08	PPm	0	300	0	0	5	0	1	3	0	58	1
29-Nov-08	PSF	2000	108	0	11	19	0	106	0	850	9	0
29-Nov-08	TB	0	11	0	0	40	0	4	0	80	3	0
29-Nov-08	WB	0	0	0	0	0	0	0	0	0	0	1

Start Date	Site Name	SumOfGrey-tailed Tattler	SumOfHooded Plover	SumOfLesser Sandplover	SumOfLesser Sandplover1	SumOfMarsh Sandpiper	SumOfMasked Lapwing	SumOfPacific Golden Plover	SumOfPectoral Sandpiper	SumOfPied Oystercatcher	SumOfRed Knot
29-Nov-08	Abr	0	0	0	0	0	0	0	0	0	0
29-Nov-08	Abw	0	0	0	0	0	34	0	0	0	0
29-Nov-08	BIW	0	0	0	0	6	2	0	0	0	0
29-Nov-08	BP	0	0	0	0	15	0	0	0	0	0
29-Nov-08	Crka	0	0	0	0	0	0	0	0	0	0
29-Nov-08	CI	0	0	0	0	0	6	0	0	0	0
29-Nov-08	DCS	0	0	0	0	1	100	0	1	4	0
29-Nov-08	GPC	0	2	0	0	0	2	0	0	2	0
29-Nov-08	MRW	0	0	0	0	5	3	0	0	0	0
29-Nov-08	MB	1	0	0	0	1	2	0	0	3	0
29-Nov-08	PA	0	0	0	0	0	2	0	0	2	0
29-Nov-08	PC	0	0	0	0	0	0	0	0	3	0
29-Nov-08	PG	0	0	0	0	1	2	0	0	3	0
29-Nov-08	PPhm	0	0	0	0	0	0	5	0	2	0
29-Nov-08	PPm	0	0	0	0	0	0	0	0	4	1000
29-Nov-08	PSF	0	0	0	0	5	1	0	0	9	150
29-Nov-08	TB	0	0	1	1	1	0	0	0	0	0
29-Nov-08	WB	0	0	6	6	0	0	0	0	0	0

Start Date	SiteName	SumOfRed-capped Plover	SumOfRed-kneed Dotterel	SumOfRed-necked Avocet	SumOfRed-necked Stint	SumOfRuddy Turnstone	SumOfSharp-tailed Sandpiper	SumOfSooty Oystercatcher	SumOfWhimbrel	SumOfWood Sandpiper	Total Birds by site
29-Nov-08	Abr	0	0	0	100	0	0	0	0	0	79662
29-Nov-08	Abw	0	0	0	0	0	121	0	0	0	79747
29-Nov-08	BIW	4	46	0	1	0	8	0	0	1	79681
29-Nov-08	BP	3	0	0	200	8	0	1	0	0	79789
29-Nov-08	Crka	0	0	0	0	0	0	0	0	0	79562
29-Nov-08	CI	0	0	0	30	0	20	0	0	0	79628
29-Nov-08	DCS	27	6	55	4825	0	472	0	0	0	95602
29-Nov-08	GPC	20	0	0	30	0	5	1	0	0	79635
29-Nov-08	MRW	9	20	0	60	0	280	0	0	1	79971
29-Nov-08	MB	14	7	0	24	0	31	0	0	0	79655
29-Nov-08	PA	3	0	0	16	0	0	0	0	0	79588
29-Nov-08	PC	0	30	0	50	4	0	0	0	0	79666
29-Nov-08	PG	414	0	0	0	0	29	0	0	0	80069
29-Nov-08	PPhm	92	0	0	600	0	0	0	0	0	80290
29-Nov-08	PPm	22	40	0	2581	2	206	0	0	0	83785
29-Nov-08	PSF	5	3	500	103	3	49	0	6	0	83499
29-Nov-08	TB	20	0	0	200	50	150	0	0	0	80123
29-Nov-08	WB	25	0	0	220	0	13	0	0	0	79833

Start Date	SiteName	SumOfBanded Lapwing	SumOfBanded Stilt	SumOfBar-tailed Godwit	SumOfBlack-winged Stilt	SumOfCommon Greenshank	SumOfCommon Sandpiper	SumOfCurlew Sandpiper	SumOfDouble-banded Plover	SumOfEastern Curlew	SumOfGreat Knot	SumOfGrey Plover
28-Feb-09	DCS	0		0	82	142	0	46	0	0	0	44
28-Feb-09	LB	90	2	25	0	80	0	74	0	27	70	50
28-Feb-09	MRW	0	0	0	0	0	0	0	0	0	0	0
28-Feb-09	MB	0	0	0	0	17	0	0	0	0	0	0
28-Feb-09	PA	0	0	0	0	3	0	0	0	0	0	0
28-Feb-09	PC	0	0	77	0	12	0	6	0	1	0	20
28-Feb-09	PG	0	0	0	0	28	2	62	4	0	0	8
28-Feb-09	PJ	0	0	0	0	0	0	0	0	0	0	0
28-Feb-09	PPhm	0	0	46	0	16	0	0	0	0	4	10
28-Feb-09	PPm	0	0	275	0	8	0	50	0	0	100	80
28-Feb-09	PSF	0	3250	110	12	128	2	151	0	0	17	17
28-Feb-09	TB	0	0	24	0	85	0	2	0	0	13	10
28-Feb-09	WB	0	0	0	0	0	0	0	0	0	1	0

Start Date	SiteName	SumOfGreater Sandplover	SumOfGrey-tailed Tattler	SumOfHooded Plover	SumOfLesser Sandplover	SumOfLesser Sandplover1	SumOfMarsh Sandpiper	SumOfMasked Lapwing	SumOfPacific Golden Plover	SumOfPied Oystercatcher	SumOfRed Knot
28-Feb-09	DCS	0	0	0	0	0	1	56	2	0	0
28-Feb-09	LB	0	0	0	0	0	0	9	0	12	500
28-Feb-09	MRW	0	0	0	0	0	0	4	0	0	0
28-Feb-09	MB	0	0	0	0	0	0	0	0	0	0
28-Feb-09	PA	0	0	0	0	0	0	2	0	0	0
28-Feb-09	PC	0	4	0	1	1	0	0	0	17	40
28-Feb-09	PG	0	0	0	3	3	6	9	0	0	1
28-Feb-09	PJ	0	0	5	0	0	0	0	0	0	0
28-Feb-09	PPhm	0	0	0	0	0	15	7	0	0	40
28-Feb-09	PPm	1	0	0	0	0	0	10	0	0	1000
28-Feb-09	PSF	0	0	0	0	0	0	18	0	10	93
28-Feb-09	TB	0	0	0	4	4	0	5	0	0	1
28-Feb-09	WB	7	0	0	0	0	0	3	0	0	0

Start Date	SiteName	SumOfRed-capped Plover	SumOfRed-kneed Dotterel	SumOfRed-necked Avocet	SumOfRed-necked Stint	SumOfRuddy Turnstone	SumOfSharp-tailed Sandpiper	SumOfSooty Oystercatcher	SumOfTerek Sandpiper	SumOfWhimbrel	SumOfWood Sandpiper	Total Birds by site
28-Feb-09	DCS	567	85	35	1027	0	353	0	0	0	0	82184
28-Feb-09	LB	1000	0	0	1200	0	3	0	0	0	0	82886
28-Feb-09	MRW	4	0	0	0	0	0	0	0	0	0	79752
28-Feb-09	MB	0	0	0	0	0	11	0	0	0	0	79772
28-Feb-09	PA	25	0	0	40	0	0	0	0	0	0	79814
28-Feb-09	PC	66	0	0	102	20	5	0	0	0	0	80116
28-Feb-09	PG	540	9		770	8	155	0	0	0	0	81352
28-Feb-09	PJ	12	0	0	0	0	0	7	0	0	0	79768
28-Feb-09	PPhm	113	0	0	367	10	8	0	0	0	0	80380
28-Feb-09	PPm	430	0	0	2000	2	300	0	0	0	0	84000
28-Feb-09	PSF	220	27	250	679	29	318	0	1	18	2	85096
28-Feb-09	TB	20	0	0	58	18	1	0	0	0	0	79989
28-Feb-09	WB	0	0	0	0	0	0	0	0	0	0	79755

Table 9. Threat totals for shorebird areas in the Gulf of Saint Vincent.

Count Area	Human induce habitat loss totals	Human disturbance totals	Invasive species totals	Pollution Totals	threat score totals
Aldinga Beach, (reef)	7	7	5	1	20
Aldinga Beach, (Washpool)	4	2	5	3	14
Bald Hill	1	0	1	0	2
Barker Inlet Wetlands	0	7	7	7	21
Black Point	5	6	7	0	18
Clinton Conservation Park	0	0	5	0	5
Dry Creek Saltfields	0	5	6	6	17
Giles Point, Coobowie	0	0	5	0	5
Light Beach	0	4	5	0	9
Magazine Road Wetlands	0	0	6	0	6
Middle Beach area	6	6	6	4	22
Pine Point	3	**8**	6	5	22
Port Arthur	0	5	5	0	10
Port Clinton	6	7	6	5	24
Port Gawler seafront next to ICI saltworks	0	6	4	0	10
Port Julia	0	7	4	0	11
Port Parham	0	7	6	1	14
Port Prime area	1	6	5	4	16
Price Saltfields	3	3	3	3	12
Saint Kilda	**8**	7	7	7	29
Salt Creek, Coobowie	**8**	1	3	0	12
Section Banks, Outer Harbour	4	6	6	6	22
Thompson Beach	0	7	5	3	15
Thompson Beach North	0	7	5	3	15
Thompson Beach South	0	7	5	3	15
Tiddy Widdy - Price coast	3	6	3	2	14
Webb Beach	0	7	6	3	16

Appendix C. Metadata for three GIS layers.

Metadata for Gulf of Saint Vincent Shorebird Areas GIS Layer

Title: Gulf of Saint Vincent Shorebird Areas (Boundaries) - 1:10,000 scale

Dataset name: GSV shorebird areas

Abstract: This dataset is a polygon representation of known important areas for resident and migratory shorebirds in Gulf of Saint Vincent from Drycreek Saltfields on the east to the east end of Cooboowie Inlet. These areas include known areas where shorebirds congregate for feeding and/or roosting as well as known suitable Hooded Plover Habitat. This data is intended to be an aid to planning and management decisions and assist in the maintenance and monitoring of known important shorebird areas. Data was digitised using ortho-rectified satellite images viewed at 1:1,000, and boundaries were based on ground surveys using GPS.

Search word(s): Resident Shorebirds, Migratory Shorebirds

Dataset topic: Category: Biota

Dataset language: English

Dataset status: Current as at completion date

Date of completion: 14 June 2009

Maintenance/Update: On-going maintenance, up-dates recommended every five years

Access constraints: None

Use constraints: None

Dataset format: ESRI ArcMap Shapefile

Data type: Vector

Coordinate system: Geocentric Datum of Australia 1994 (GDA94)

Geographic extent: Gulf of Saint Vincent, SA.

Geographic Full Extent (GDA 1994):

West_Bounding_Coordinate:	133.3918
East_Bounding_Coordinate:	140.8912
North_Bounding_Coordinate:	-27.8394
South_Bounding_Coordinate:	-38.0647

Data Quality Information:

Positional Accuracy Precision

<25 m – 500 m

Determination of Accuracy

Similar spatial database suggests that GSV shorebird areas maps at 1:10,000 are accurate to <100 m. Additional inaccuracy may be introduced by the dynamic nature of shorebird habitats (e.g. through the erosion and deposition of sediments). For example, ground-truthing of areas in Se Australia has identified positional shifts of up to 500 m in polygon boundaries over just seven years. Further positional changes may be expected following changes to the distribution of vegetation. Periodic re-surveys are recommended.

Collection Method

Screen digitising satellite images viewed at 1:1000 in addition to collection of Ground Control Points using a GPS. Where appropriate previous digital shorebird area boundaries from Birds Australia were used as was historic habitat location data (see Historic Data Source). The location of shorebird areas was updated, where necessary, following this process. Shorebird areas encompass all areas of habitat between which regular shorebird movements are known to occur. Thus, each shorebird area is seen to be used collectively used by the same shorebird population.

Attribute Accuracy

Due to logistical constraints, limited ground-truthing of the dataset has been undertaken. Nevertheless, as attribute information has been based on consultation with local shorebird experts from around the country, it is considered as accurate as possible given the broad spatial coverage of the dataset.

Logical Consistency

All polygons are labelled, but the dataset has not been 'cleaned' (i.e. dangling nodes/sliver polygons removed). This process is recommended.

Completeness

This dataset contains all shorebird areas to be surveyed regularly as part of the ongoing, Australia-wide Population Monitoring Program for shorebirds. It also contains a number of additional areas known to be important for resident and migratory shorebird species in Australia.

Attribute Information:

ID	Unique ID number for each shorebird area (matches that in National Shorebird Database maintained by Birds Australia)
SBIRD_AREA	Name of shorebird area
NAME_BAMFO	Name of the internationally important sites identified in (Bamford et al. 2008), the boundaries of sites do not always match the boundaries identified here, but future work should allow them to match up.
BOUNDARY_C	A subjective score on how well the mapped shorebird area boundary is known to capture the shorebird habitat found there. 5 = major spring tide roosts have been mapped, along with some other habitats used, and the outer boundary is known to capture the important shorebird habitat, 4 = confident that outer boundary captures shorebird habitat, some identification of habitat within the area, and areas counted, 3 = Outer boundary may need some adjustment, but core of shorebird habitat is thought to have been captured within, 2 = from the count data (which might be ascribed to only a point location, identified the extent of the habitat which occurs in the area), 1 = extent of area used by shorebirds and boundary of available habitat not certain.
STATE	State in which the shorebird area is located
LONGITUDE	Longitude in decimal degrees
LATITUDE	Latitude in decimal degrees
AREA_HA	Area (ha) of shorebird area
PERIM_M	Perimeter (m) of shorebird area
SOURCE	Source of information regarding shorebird area location and boundary position, often these include the individual shorebird experts consulted
HABITAT	Brief description of the habitat/s found in the shorebird area
COMMENTS	Any additional information regarding the shorebird area
INT_SIG	Identifies whether the shorebird area is classified as Internationally Significant for shorebirds based on data held at Birds Australia National Office Melbourne (see Appendix 1)
IN_SIG_BAM	Areas identified by any known data signifying an area is internationally significant (Bamford et al 2008)
NAT_SIG	Identifies whether the shorebird area is classified at Nationally Significant for shorebirds
STATE_SIG	Identifies whether the shorebird area is classified as Significant for shorebirds at the State level
REG_SIG	Identifies whether the shorebird area is classified as Regionally Significant
HAB_LOSS	Describes the scale of habitat loss affecting the shorebird area (see Appendix 2)
HUM_DIST	Describes the level of human disturbance affecting the shorebird area
INV_SP	Describes the impact of invasive species on the shorebird area
POLLUTION	Describes the level of pollution in the shorebird area
ACC_MORT	Describes the potential for accidental mortality of birds in the shorebird area
THREAT	Additional comments regarding any threats affecting the shorebird area
YEARS_DATA	Number of years of count data collected in the shorebird area
TOTAL_RICH	Total number of all shorebird species recorded in the shorebird area
MIG_RICH	Total number of migrant species recorded in the shorebird area
MAX_AB_SP	Maximum annual abundance of all shorebird species in the shorebird area
AVG_AB_SP	Mean annual abundance of all shorebird species in the shorebird area
MAX_AB_MIG	Maximum annual abundance of migrant species in the shorebird area
AVG_AB_MIG	Mean annual abundance of all migrant species in the shorebird area

Where data is available, maximum (_MAX) and mean (_AVG) annual counts recorded in the shorebird area is listed for the following species:

Metadata for the Gulf of Saint Vincent Shorebird Count Areas GIS Shapefile

Title: Gulf of Saint Vincent Shorebird Areas (Boundaries) - 1:10,000 scale

Dataset name: GSV shorebird count areas

Abstract: This dataset is a polygon representation of specific survey locations, termed 'count areas', for monitoring of resident and migratory shorebird numbers in Australia. Each count area falls into one of three categories: those contained within known 'shorebird areas', those located outside of shorebird areas, and those that have been randomly selected to increase the geographic coverage of shorebird surveys. The count data collected during these surveys will contribute to the ongoing, Australia-wide Population Monitoring Program for shorebirds. These count areas form the smallest sampling unit by which important shorebird areas in Australia will be monitored and may be aggregated with other count areas to form larger 'shorebird areas'. Thus, count areas form the basis for the systematic sampling of important shorebird habitats in Australia, and describe the required coverage for any shorebird count to be considered complete. In shorebird areas with many years of historic data count areas represent the historic coverage for those counts, but for area with little data, count areas are often reflect the areas that will be surveyed in future, and some of the data ascribed to those areas may have been collected beyond the mapped boundaries.

National database records have contributed to this dataset (digitised at Birds Australia national office, based on expert advice and mapping from throughout the country). The Gulf of Saint Vincent, count areas have been digitised using ortho-rectified satellite images viewed at 1:1,000, in consultation with the shorebird ground survey made during Feb –Mar 2009.

These count areas differ widely in terms of the number of annual shorebird counts undertaken in each. Available data for a range of resident and migratory species is summarised. This data is intended to increase standardisation of shorebird population monitoring and to aid planning and management decisions by providing attributes for each area.

Search word(s): Resident Shorebirds, Migratory Shorebirds

Dataset topic: Category: Biota

Dataset language: English

Dataset status: Current as at completion date

Date of completion: 14 June 2009

Maintenance/Update: On-going maintenance, up-dates recommended every five years

Access constraints: None

Use constraints: None

Dataset format: ESRI ArcMap Shapefile

Data type: Vector

Coordinate system: Geocentric Datum of Australia 1994 (GDA94)

Geographic extent: Gulf of Saint Vincent, SA.

Geographic Full Extent (GDA 1994):

West_Bounding_Coordinate: 133.3918
East_Bounding_Coordinate: 140.8912

North_Bounding_Coordinate: -27.8394
South_Bounding_Coordinate: -38.0647

Data Quality Information:

Positional Accuracy Precision

<25 m – 500 m

Determination of Accuracy

Similar spatial database suggests that GSV shorebird areas maps at 1:10,000 are accurate to <100 m. Additional inaccuracy may be introduced by the dynamic nature of shorebird habitats (e.g. through the erosion and deposition of sediments). For example, ground-truthing of areas in Se Australia has identified positional shifts of up to 500 m in polygon boundaries over just seven years. Further positional changes may be expected following changes to the distribution of vegetation. Periodic re-surveys are recommended.

Collection Method

Screen digitising satellite images viewed at 1:1000 in addition to collection of Ground Control Points using a GPS. Where appropriate previous digital shorebird area boundaries from Birds Australia were used as was historic habitat location data (see Historic Data Source). The location of shorebird areas was updated, where necessary, following this process. Shorebird areas encompass all areas of habitat between which regular shorebird movements are known to occur. Thus, each shorebird area is seen to be used collectively used by the same shorebird population.

Attribute Accuracy

Due to logistical constraints, limited ground-truthing of the dataset has been undertaken (except in the case of regional datasets). Nevertheless, attribute information has been based on consultation with local shorebird experts from around the country.

Logical Consistency

All polygons are labelled.

Completeness

This dataset contains all count areas that will be regularly surveyed as part of the ongoing, Australia-wide Population Monitoring Program for shorebirds.

Attribute Information:

ID	Unique ID number for each count area (matches that in National Shorebird Database maintained by Birds Australia)
STATE	State in which the count area is located
SBIRD_AREA	Name of shorebird area in which the count area is located
COUNT_AREA	Name of count area
CODE	Unique code used to identify the count area
HABITAT	Brief description of the habitat/s found in the count area
COMMENTS	Any additional information regarding the count area
SOURCE	Source of information regarding count area location and boundary position
PERIMETER_	Perimeter (m) of count area
HECTARES	Area (ha) of count area
LONGITUDE	Longitude in decimal degrees
LATITUDE	Latitude in decimal degrees
TOTAL_RICH	Total number of all shorebird species recorded in the count area
MIG_RICH	Total number of migrant species recorded in the count area
NUMB_VISIT	Number of counts ascribed to each count area
NUMB_YEARS	Number of years in which a count was submitted for each count area

Where data is available, the maximum (_MAX) and mean (_AVG) annual count recorded in the count area is listed for the following species:

Asian Dowitcher (ASDO)
Australian Pratincole (AUPR)
Banded Lapwing (BALA)
Bar-tailed Godwit (BAGO)
Banded Stilt (BAST)
Black-fronted Dotterel (BLDO)
Black-tailed Godwit (BLGO)
Black-winged Stilt (BLST)
Broad-billed Sandpiper (BRSA)
Common Greenshank (COGR)
Common Redshank (CORE)
Common Sandpiper (COSA)
Curlew Sandpiper (CUSA)

Double-banded Plover (DOPL)
Eastern Curlew (EACU)
Great Knot (GRKN)
Grey Plover (GRPL)
Greater Sand Plover (GRSA)
Grey-tailed Tattler (GRTA)
Hooded Plover (HOPL)
Latham's Snipe (LASN)
Lesser Sand Plover (LESA)
Little Curlew (LICU)
Little Ringed Plover (LIPL)
Long-toed Stint (LOST)
Masked Lapwing (MALA)
Marsh Sandpiper (MASA)
Oriental Plover (ORPL)
Oriental Pratincole (ORPR)
Pacific Golden Plover (PAPL)
Pectoral Sandpiper (PESA)
Pied Oystercatcher (PIOY)
Pin-tailed Snipe (PISN)
Red-necked Avocet (REAV)
Red-kneed Dotterel (REDO)
Red Knot (REKN)
Red-necked Phalarope (REPH)
Red-capped Plover (REPL)
Red-necked Stint (REST)
Ruff (RUFF)
Ruddy Turnstone (RUTU)
Sanderling (SAND)
Sharp-tailed Sandpiper (SHSA)
Sooty Oystercatcher (SOOY)
Swinhoe's Snipe (SWSN)
Terek Sandpiper (TESA)
Wandering Tattler (WATA)
Whimbrel (WHIM)
Wood Sandpiper (WOSA)

MAX_AB_ALL	Maximum annual abundance of all shorebird species in the count area
AVG_AB_ALL	Mean annual abundance of all shorebird species in the count area
MAX_AB_MIG	Maximum annual abundance of migrant species in the count area
AVG_AB_MIG	Mean annual abundance of all migrant species in the count area
HAB_LOSS	Describes the scale of habitat loss affecting the shorebird area (see Appendix 2)
HUM_DIST	Describes the level of human disturbance affecting the shorebird area
INV_SP	Describes the impact of invasive species on the shorebird area
POLLUTION	Describes the level of pollution in the shorebird area
Threat Score	Cumulative score of all threats affecting the shorebird area

Base layer data source:

Whyalla to Port Gawler Coastal project (Area3) 2006
Digital Base Layer Format: 2 Digital (Pan-sharpened 4bands) Satellite Image ECW format (Satellite image flown in 2006 with 45cm ground resolution)
Flight Scale: 1:20000 (equivalent)
Survey and Flight Date: 7032 (March, April 2006)
Altitude: 5100ASL

Name: PortWakefield_to DryCreek_2006_LCC.ers
Data File: PortWakefield_to DryCreek_2006_LCC.ecw
Data Type: Raster Digital File
Coordinate Space Begin:
Datum: GDA94
Projection:
Lambert_Conformal_Conic
false_easting: 1000000.000000
false_northing: 2000000.000000
central_meridian: 135.000000
standard_parallel_1: -28.000000
standard_parallel_2: -36.000000
latitude_of_origin: -32.000000
Linear Unit: Meter

Extent:
North: 1777938.19978
West: 1262539.45437
East: 1341534.70437
South: 1676185.99978

Name: MarionBay_toClinton_LCC.ers
Data File: MarionBay_toClinton_LCC.ecw
Data Type: Raster Digital File
Coordinate Space Begin:
Datum: GDA94
Projection:
Lambert_Conformal_Conic
false_easting: 1000000.000000
false_northing: 2000000.000000
central_meridian: 135.000000
standard_parallel_1: -28.000000
standard_parallel_2: -36.000000
latitude_of_origin: -32.000000
Linear Unit: Meter

Extent:
North: 1768500.06834
West: 1174500.01417
East: 1291500.01417
South: 1633500.06834

Source data acknowledgements:
Satellite images were supplied by the Department of Environment and Heritage, South Australia. Special appreciation is due to Paul Wainwright for taking the time to make the base satellite image available to this project.

Birds Australia [National Shorebird Count Areas - 1:100,000 scale]

Polygons were taken from national shorebird count area GIS layer as historic data and as start point for digitizing the Gulf of Saint Vincent shorebird count areas. Most attributes have been added from these polygons where taken for the digitized areas and values were updated where necessary.

Further maps, data summaries, and area descriptions available online.
http://www.birdsaustralia.com.au/our-projects/iba-maps.html

Dataset and metadata point of contact:

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Metadata date: 14 June 2009

Asian Dowitcher (ASDO)
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Banded Stilt (BAST)
Black-fronted Dotterel (BLDO)
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Black-winged Stilt (BLST)
Broad-billed Sandpiper (BRSA)
Common Greenshank (COGR)
Common Redshank (CORE)
Common Sandpiper (COSA)
Curlew Sandpiper (CUSA)
Double-banded Plover (DOPL)
Eastern Curlew (EACU)
Great Knot (GRKN)
Grey Plover (GRPL)
Greater Sand Plover (GRSA)
Grey-tailed Tattler (GRTA)
Hooded Plover (HOPL)
Latham's Snipe (LASN)
Lesser Sand Plover (LESA)
Little Curlew (LICU)
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Pacific Golden Plover (PAPL)
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Red-kneed Dotterel (REDO)
Red Knot (REKN)
Red-necked Phalarope (REPH)
Red-capped Plover (REPL)
Red-necked Stint (REST)
Ruff (RUFF)
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Sanderling (SAND)
Sharp-tailed Sandpiper (SHSA)
Sooty Oystercatcher (SOOY)
Swinhoe's Snipe (SWSN)
Terek Sandpiper (TESA)
Wandering Tattler (WATA)
Whimbrel (WHIM)
Wood Sandpiper (WOSA)

Base layer data source:

Whyalla to Port Gawler Coastal project (Area3) 2006
Digital Base Layer Format: 2 Digital (Pan-sharpened 4bands) Satellite Image ECW format
(Satellite image flown in 2006 with 45cm ground resolution)
Flight Scale: 1:20000 (equivalent)
Survey and Flight Date: 7032 (March, April 2006)
Altitude: 5100ASL

Name: PortWakefield_to DryCreek_2006_LCC.ers
Data File: PortWakefield_to DryCreek_2006_LCC.ecw
Data Type: Raster Digital File
Coordinate Space Begin:
Datum: GDA94
Projection:
Lambert_Conformal_Conic

false_easting: 1000000.000000
false_northing: 2000000.000000
central_meridian: 135.000000
standard_parallel_1: -28.000000
standard_parallel_2: -36.000000
latitude_of_origin: -32.000000
Linear Unit: Meter

Extent:
North: 1777938.19978
West: 1262539.45437
East: 1341534.70437
South: 1676185.99978

Name: MarionBay_toClinton_LCC.ers
Data File: MarionBay_toClinton_LCC.ecw
Data Type: Raster Digital File
Coordinate Space Begin:
Datum: GDA94
Projection:
Lambert_Conformal_Conic
false_easting: 1000000.000000
false_northing: 2000000.000000
central_meridian: 135.000000
standard_parallel_1: -28.000000
standard_parallel_2: -36.000000
latitude_of_origin: -32.000000
Linear Unit: Meter

Extent:
North: 1768500.06834
West: 1174500.01417
East: 1291500.01417
South: 1633500.06834

Source data acknowledgements:
Satellite images were supplied by the Department of Environment and Heritage, South Australia. Special appreciation is due to Paul Wainwright for taking the time to make the base satellite image available to this project.

Birds Australia [National Shorebird Areas - 1:100,000 scale]

Polygons were taken from national shorebird area GIS layer as historic data and as start point for digitizing the Gulf of Saint Vincent shorebird areas. Most attributes have been added from these polygons where taken for the digitized areas and values were updated where necessary.

Further maps, data summaries, and area descriptions available online.
http://www.birdsaustralia.com.au/our-projects/iba-maps.html

Dataset and metadata point of contact:

Organisation: Birds Australia
Contact's position: Shorebirds 2020 Technical Manager
Contact person: Rob Clemens
Phone: 03 9347 0757
Fax: 03 9347 9323
Address: Suite 2-05
60 Leicester St
Carlton VIC 3053
Australia
e-mail: r.clemens@birdsaustralia.com.au
Website: www.birdsaustralia.com.au
Metadata date: 14 June 2008

Listed below are the criteria used to identify shorebird areas providing significantly important habitat for shorebirds. Four levels of significance are employed: International, National, State and Regional. Shorebird areas are considered significant at a given level if they meet any of the thresholds associated with that level.

International:	**a)** Shorebird areas containing ≥ 1% of the flyway population estimate of any migrant species (see Watkins 1993, Bamford *et al.* 2008 for flyway population estimates). **b)** Shorebird areas containing ≥ 20,000 total abundance of shorebirds (resident and migrant species combined: calculated based on maximum count averaged across years for which data is available)
National:	**a)** Shorebird areas containing ≥ 0.1% of the flyway population estimate for migrant species **b)** Shorebird areas containing ≥ 2,000 total abundance of shorebirds (resident and migrant species combined: calculated based on maximum count averaged across years for which data is available)
State:	**a)** Shorebird areas identified in the literature as showing significant declines in shorebirds known not to be declining throughout Australia. (i.e.Red-necked Stint numbers) **b)** Shorebird areas in which evidence suggests species are showing greater declines than have been identified in other areas.
Regional:	**a)** ≥ 15 migrant species recorded in the shorebird area **b)** ≥ 20 resident and migrant species recorded in the shorebird area **c)** The three shorebird areas with the highest abundance of any of five species in each NRM region across Australia. Species included were: Little Curlew, Australian Pratincole, Oriental Pratincole, Oriental Plover and Latham's Snipe (abundance calculated by taking the maximum count of each species, averaged across years for which data was available).

For each shorebird area, five threats were scored on a scale between 0-9 to reflect the timing, scope and severity of each. Threats included habitat loss, human disturbance, invasive species, pollution and accidental mortality. A score of 0-1 indicates that the threat has a negligible affect on shorebirds in the area; 2-5 = low impact, 6-7 = medium impact and 8-9 = high impact.

References

Bamford, M. J., D. G. Watkins, W. Bancroft, G. Tischler, and J. Wahl. 2008. Migratory Shorebirds of the East Asian-Australasian Flyway; Population Estimates and Important Sites. *in*. Wetlands International, Oceania.

Watkins, D. 1993. A national plan for shorebird conservation in Australia. RAOU Report No. 90, Australasian Wader Study Group, Melbourne, Australia.

Metadata for Gulf of Saint Vincent Shorebird Habitat, Feeding and Roosting Areas GIS shapefile

Title: Gulf of Saint Vincent Shorebird Feeding and Roosting Areas - 1:25,000 scale

Dataset name: GSV shorebird feed & roost habitat

Abstract: This dataset is a polygon representation of known important areas for resident and migratory shorebirds in Gulf of Saint Vincent from Drycreek Saltfields on the east to the east end of Cooboowie Inlet. These areas include known areas where shorebirds congregate for feeding and/or roosting as well as known suitable Hooded Plover Habitat. This data is intended to be an aid to planning and management decisions and assist in the maintenance and monitoring of known important shorebird areas in Australia. Data was digitised using ortho-rectified satellite images viewed at 1:1,000

Search Word(s): Resident Shorebirds, Migratory Shorebirds, Roost site, Feeding Area

Dataset topic: Category: Biota

Dataset language: English

Dataset status: Current as at completion date

Date of completion: 14 June 2009

Maintenance/Update: On-going maintenance, up-dates recommended every five years

Access constraints: None

Use constraints: None

Dataset format: ESRI ArcMap Shapefile

Data type: Vector

Coordinate system: Geocentric Datum of Australia 1994 (GDA94)

Geographic extent: Gulf of Saint Vincent, SA.

Geographic Full Extent (GDA 1994):

West_Bounding_Coordinate:	133.3918
East_Bounding_Coordinate:	140.8912
North_Bounding_Coordinate:	-27.8394
South_Bounding_Coordinate:	-38.0647

Data Quality Information:

Positional Accuracy Precision

<25 m – 50 m

Determination of Accuracy

Similar spatial database suggests that GSV shorebird areas maps at 1:10,000 are accurate to <100 m. Additional inaccuracy may be introduced by the dynamic nature of shorebird habitats (e.g. through the erosion and deposition of sediments). For example, ground-truthing of areas in Se Australia has identified positional shifts of up to 500 m in polygon boundaries over just seven years. Further positional changes may be expected following changes to the distribution of vegetation. Periodic re-surveys are recommended.

Collection Method

Screen digitising satellite images viewed at 1:1000 in addition to collection of Ground Control Points using a GPS. Where appropriate previous digital shorebird area boundaries from Birds Australia were used as was historic habitat location data (see Historic Data Source). The location of shorebird areas was updated, where necessary, following this process. Shorebird areas encompass all areas of habitat between which regular shorebird movements are known to

occur. Thus, each shorebird area is seen to be used collectively used by the same shorebird population.

Attribute Accuracy

For regional datasets, ground-truthing was undertaken to verify attribute information. Further, historic data and a literature review (Clemens, R. and D. Rogers. 2007. Shorebird Habitat Mapping Project: West Gippsland. *Unpublished Report.* Birds Australia, Carlton, Victoria) were also used to verify accuracy of West Gippsland mapping. Due to logistical constraints, limited ground-truthing of the national dataset has been undertaken. Nevertheless, attribute information has been based on consultation with local shorebird experts from around the country.

Logical Consistency

All polygons are labelled.

Completeness

Major Roosting areas have been identified, but some minor roosts may yet be unidentified especially in areas bounded by impenetrable mangroves, or private/government land. Other areas that may be used in conditions other than those witnessed during the field surveys may also remain unidentified.

Feeding areas used when conditions are different than those observed during the survey were likely not identified. Any sand or mud-flat exposed at low tide has the potential to support low densities of feeding shorebirds, but only areas where shorebirds were observed feeding during 2009 surveys or from historic records have been identified.

Shorebird areas for species that tend not to aggregate or only occur as vagrants were not well represented by these polygons..

Attribute Information:

ID	Unique ID number of all polygons
AREA_TYPE	Identifies whether the habitat is used by shorebirds for feeding, roosting, or both
SBIRD_AREA	Name of shorebird area in which the feeding and/or roosting habitat is located
STATE	Australian State in which the feeding and/or roosting habitat is located
SOURCE_GIS	Note from which data set the polygon came from, national or one of regional
SOURCE	Source of information regarding habitat type, location and boundary position
THREATS	Brief overview of known or potential threats
HABITAT	Brief description of the associated habitat type/s
COMMENTS	Any additional information regarding the feeding and/or roosting habitat
PERIMETER_	Perimeter (m) of feeding and/or roosting habitat
HECTARES	Area (ha) of feeding and/or roosting
LONGITUDE	Longitude in decimal degrees
LATITUDE	Latitude in decimal degrees

Base layer data source:

Whyalla to Port Gawler Coastal project (Area3) 2006
Digital Base Layer Format: 2 Digital (Pan-sharpened 4bands) Satellite Image ECW format (Satellite image flown in 2006 with 45cm ground resolution)
Flight Scale: 1:20000 (equivalent)
Survey and Flight Date: 7032 (March, April 2006)
Altitude: 5100ASL
Name: PortWakefield_to DryCreek_2006_LCC.ers
Data File: PortWakefield_to DryCreek_2006_LCC.ecw
Data Type: Raster Digital File
Coordinate Space Begin:
Datum: GDA94
Projection:
Lambert_Conformal_Conic
false_easting: 1000000.000000
false_northing: 2000000.000000
central_meridian: 135.000000
standard_parallel_1: -28.000000
standard_parallel_2: -36.000000
latitude_of_origin: -32.000000

Linear Unit: Meter

Extent:
North: 1777938.19978
West: 1262539.45437
East: 1341534.70437
South: 1676185.99978

Name: MarionBay_toClinton_LCC.ers
Data File: MarionBay_toClinton_LCC.ecw
Data Type: Raster Digital File
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Datum: GDA94
Projection:
Lambert_Conformal_Conic
false_easting: 1000000.000000
false_northing: 2000000.000000
central_meridian: 135.000000
standard_parallel_1: -28.000000
standard_parallel_2: -36.000000
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Source data acknowledgements:
Satellite images were supplied by the Department of Environment and Heritage, South Australia. Special appreciation is due to Paul Wainwright for taking the time to make the base satellite image available to this project.

Birds Australia [National Shorebird Feeding and Roosting Areas - 1:100,000 scale]

Polygons were taken from national shorebird feeding and roosting areas GIS layer as historic data and as starting point for digitizing the Gulf of Saint Vincent shorebird count areas. Most attributes have been added from these polygons where taken for the digitized areas and values were updated where necessary.

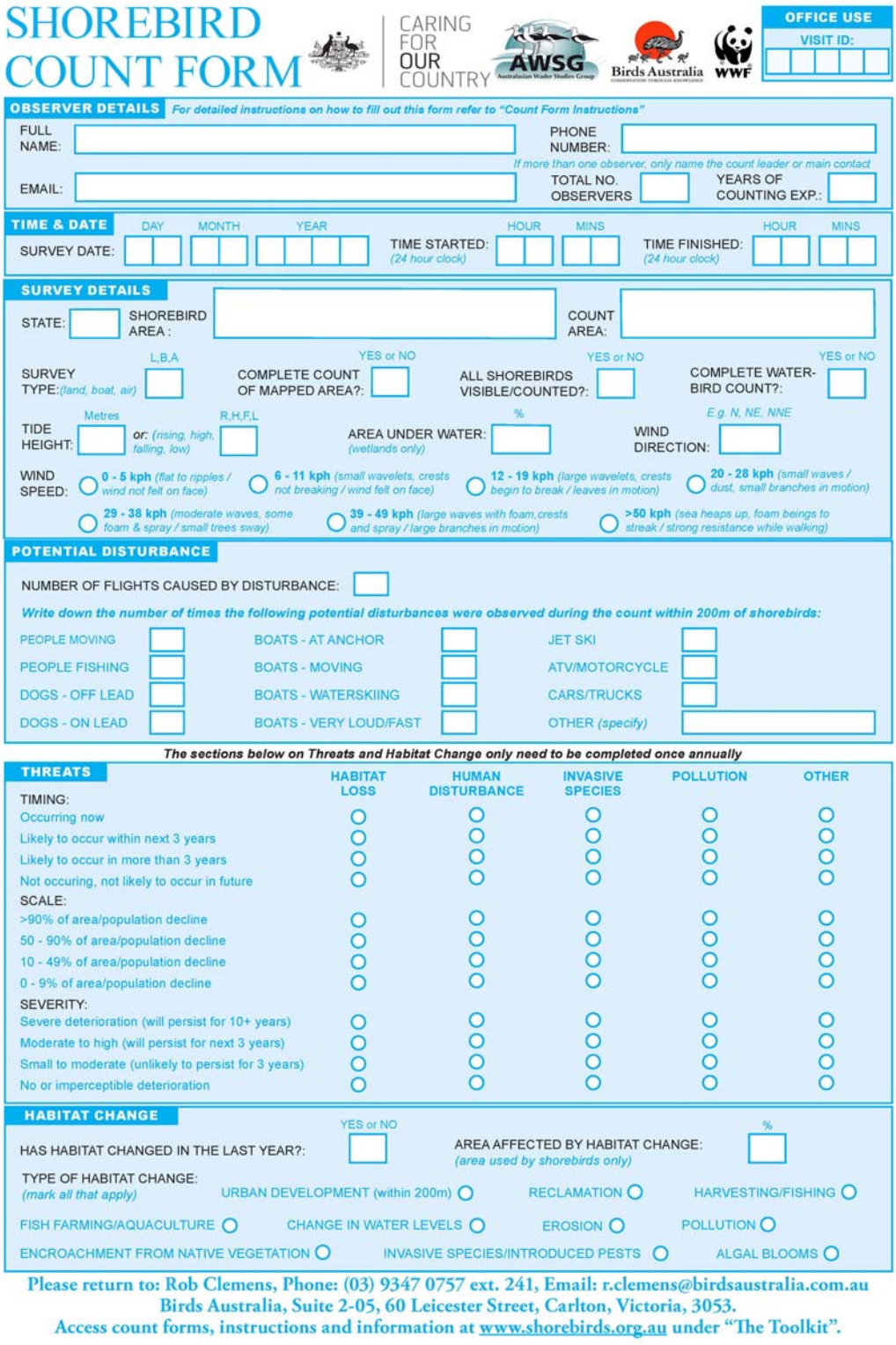
Further maps, data summaries, and area descriptions available online.
http://www.birdsaustralia.com.au/our-projects/iba-maps.html

Dataset and metadata point of contact:

Organisation: Birds Australia
Contact's position: Shorebirds 2020 Technical Manager
Contact person: Rob Clemens
Phone: 03 9347 0757
Fax: 03 9347 9323
Address: Suite 2-05
60 Leicester St
Carlton VIC 3053
Australia
e-mail: r.clemens@birdsaustralia.com.au
Website: http://www.birdsaustralia.com.au/

Metadata date: 14 June 2008

Appendix D. Shorebird Count form.



SHOREBIRD COUNT FORM

CARING FOR OUR COUNTRY | AWSG Australasian Wader Studies Group | Birds Australia | WWF

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 EXP.:

TIME & DATE

SURVEY DATE: DAY MONTH YEAR | TIME STARTED: HOUR MINS *(24 hour clock)* | TIME FINISHED: HOUR MINS *(24 hour clock)*

SURVEY DETAILS

STATE: | SHOREBIRD AREA: | COUNT AREA:

SURVEY TYPE: L,B,A *(land, boat, air)* | COMPLETE COUNT OF MAPPED AREA?: YES or NO | ALL SHOREBIRDS VISIBLE/COUNTED?: YES or NO | COMPLETE WATER-BIRD COUNT?: YES or NO

TIDE HEIGHT: Metres *or: (rising, high, falling, low)* R,H,F,L | 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 branches in motion)*
- **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)*

POTENTIAL DISTURBANCE

NUMBER OF FLIGHTS CAUSED BY DISTURBANCE:

Write down the number of times the following potential disturbances were observed during the count within 200m of shorebirds:

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)*

The sections below on Threats and Habitat Change only need to be completed once annually

THREATS

	HABITAT LOSS	HUMAN DISTURBANCE	INVASIVE SPECIES	POLLUTION	OTHER
TIMING:					
Occurring now	○	○	○	○	○
Likely to occur within next 3 years	○	○	○	○	○
Likely to occur in more than 3 years	○	○	○	○	○
Not occuring, not likely to occur in future	○	○	○	○	○
SCALE:					
>90% of area/population decline	○	○	○	○	○
50 - 90% of area/population decline	○	○	○	○	○
10 - 49% of area/population decline	○	○	○	○	○
0 - 9% of area/population decline	○	○	○	○	○
SEVERITY:					
Severe deterioration (will persist for 10+ years)	○	○	○	○	○
Moderate to high (will persist for next 3 years)	○	○	○	○	○
Small to moderate (unlikely to persist for 3 years)	○	○	○	○	○
No or imperceptible deterioration	○	○	○	○	○

HABITAT CHANGE

HAS HABITAT CHANGED IN THE LAST YEAR?: 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 ○

Please return to: Rob Clemens, Phone: (03) 9347 0757 ext. 241, Email: r.clemens@birdsaustralia.com.au
Birds Australia, Suite 2-05, 60 Leicester Street, Carlton, Victoria, 3053.
Access count forms, instructions and information at www.shorebirds.org.au under "The Toolkit".

SHOREBIRDS

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

(B)	Australian Pratincole		
	Asian Dowitcher		
(B)	Banded Lapwing		
(B)	Banded Stilt		
	Bar-tailed Godwit		
(B)	Beach Stone-curlew		
(B)	Black fronted dotterel		
	Black-tailed Godwit		
(B)	Black-winged Stilt		
	Broad-billed Sandpiper		
(B)	Bush Stone-curlew		
(B)	Comb-crested Jacana		
	Common Greenshank		
	Common Redshank		
	Common Sandpiper		
	Curlew Sandpiper		
	Double-banded Plover		
	Eastern Curlew		
	Great Knot		
	Greater Sand Plover		
	Grey Plover		
	Grey-tailed Tattler		
(B)	Hooded Plover		
	Latham's Snipe		
	Lesser Sand Plover		
	Little Curlew		
	Little Ringed Plover		
	Long-toed Stint		
	Marsh Sandpiper		
(B)	Masked Lapwing		
	Oriental Plover		
	Oriental Pratincole		
	Pacific Golden Plover		
(B)	Painted Snipe		
	Pectoral Sandpiper		
(B)	Pied Oystercatcher		
	Pin-tailed Snipe		
	Red Knot		
(B)	Red-capped Plover		
(B)	Red-kneed Dotterel		
(B)	Red-necked Avocet		
	Red-necked Phalarope		
	Red-necked Stint		
	Ruddy Turnstone		
	Ruff		
	Sanderling		
	Sharp-tailed Sandpiper		
	Swinhoe's Snipe		
(B)	Sooty Oystercatcher		
	Terek Sandpiper		
	Wandering Tattler		
	Whimbrel		
	Wood Sandpiper		
	unident. large wader		
	unident. medium wader		
	unident. small wader		
(B)	_____		
(B)	_____		
(B)	_____		
	Total Shorebirds		

GANNETS, PELICAN, CORMORANTS

(B)	Australian Pelican	
(B)	Australasian Gannet	
(B)	Black-faced Cormorant	
(B)	Darter	
(B)	Great Cormorant	
(B)	Little Black Cormorant	
(B)	Little Pied Cormorant	
(B)	Pied Cormorant	

GREBES, DUCKS, GEESE, SWANS, CRAKES

(B)	Australasian Grebe	
(B)	Australasian Shoveler	
(B)	Australian Shelduck	
(B)	Australian Wood Duck	
(B)	Black Swan	
(B)	Blue-billed Duck	
(B)	Cape Barren Goose	
(B)	Chestnut Teal	
(B)	Dusky Moorhen	
(B)	Eurasian Coot	
(B)	Great Crested Grebe	
(B)	Grey Teal	
(B)	Hardhead	
(B)	Hoary-headed Grebe	
(B)	Magpie Goose	
(B)	Mallard	
(B)	Musk Duck	
(B)	Pacific Black Duck	
(B)	Pink-eared Duck	
(B)	Plumed Whistling Duck	
(B)	Purple Swamphen	

HERONS, EGRETS, IBIS, SPOONBILLS

(B)	Australian White Ibis	
(B)	Cattle Egret	
(B)	Eastern Great Egret	
(B)	Glossy Ibis	
(B)	Intermediate Egret	
(B)	Little Egret	
(B)	Nankeen Night Heron	
(B)	Royal Spoonbill	
(B)	Straw-necked Ibis	
(B)	White-faced Heron	
(B)	White-necked Heron	
(B)	Yellow-billed Spoonbill	

GULLS, TERNS

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

EXTRA BIRDS NOT LISTED ABOVE

(B)	_____	
(B)	_____	
(B)	_____	
(B)	_____	
	Total Waterbirds	
	Overall total birds	

COMMENTS

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