SOUTH AUSTRALIAN RECOVERY PLAN FOR THE

HOODED PLOVER
Thinornis rubricollis

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1 SPECIES INFORMATION

1.1 Taxonomic comments

The Hooded Plover *Thinornis rubricollis* (Christian *et al* 1992), is endemic to southern Australia. Its closest relative is the endangered Shore Plover *T. novaeseelandiae* of New Zealand (Marchant and Higgins 1993). Mathews (1913-14) split the species into two subspecies in eastern and western Australia, as birds in Western Australia have longer bills and legs and darker backs (Marchant and Higgins 1993), but these subspecies are not currently recognised (Christidis and Boles 1994). Further study of geographical variation should result in the official resurrection of Mathew's subspecies (Weston 2003) as pre-empted by Garnett and Crowley (2000).

1.2 Legal status

The national conservation status of the Hooded Plover is in a state of flux. In 2000 the species was removed from the federal *Endangered Species* Act (1992) and was not listed under the *Environment Protection and Biodiversity Conservation* Act (1999) on the basis that secure populations exist in Western Australia (Weston 2003). If the subspecies are officially recognised then the eastern subspecies, which occurs in South Australia, is likely to be listed as vulnerable under the EPBC Act, and the western subspecies is 'near threatened' (Garnett and Crowley 2000).

Under the South Australian *National Parks and Wildlife Act* (1972) the Hooded Plover is listed as vulnerable, it is vulnerable in Victoria (DSE 2003) and listed under the *Flora and Fauna Guarantee Act* (1988). In New South Wales the Hooded Plover is listed as endangered under the *Threatened Species Conservation Act* (1995), and in Tasmania it is listed as a protected species under the *Nature Conservation Act* 2002 and treated as a species of conservation significance.

1.3 Description

The Hooded Plover is a medium-sized, stocky shorebird about 10 cm tall, 20 cm long, and weighing 90-100 g (Marchant and Higgins 1993). Both sexes have grey and white bodies with a black hood, red bill tipped black, and short, dull orange-pink legs. In flight, Hooded Plovers have a striking wing pattern with a broad white wing-bar contrasting with a black trailing edge and primary coverts. The white sides of their tail also contrasts with a black subterminal band and black central upper tail coverts. Juvenile Hooded Plovers lack the black head and hindneck, these being sandy brown or grey in colour; the bill is brown with an orange base and the legs are pale orange (Schulz 1992, Weston and Paton 2001).

The distinctive adult Hooded Plover is unlikely to be confused with any other shorebird, except perhaps Ruddy Turnstones *Arenaria interpres* in flight. The most common misidentifications occur with juveniles (Cameron and Weston 1999), which are basically grey versions of adults. Juvenile Hooded Plovers could be confused with Sanderlings *Calidris alba* and Double-banded Plovers *Charadrius hiaticula*. Unattended Hooded Plover chicks can be distinguished from Red-capped Plover *Charadrius ruficapillus* chicks by their white nape.

1.4 Distribution

Endemic to southern Australia, the Hooded Plover is now mainly found along the coast from near Jervis Bay in New South Wales, south through Victoria to Fowlers Bay in western South Australia (Garnett and Crowley 2000). They are also found in Tasmania, Kangaroo Island, King Island, Flinders Island and other nearby islands (Cameron and Weston 1999). In south-west Western Australia the Hooded Plover is not restricted to the coast, and can also live and breed around inland salt lakes (Blakers *et al* 1984).

The range of the Hooded Plover has declined in eastern Australia since European settlement (Blakers *et al.* 1984, Cameron and Weston 1999). Southern coastal Queensland and northern New South Wales were probably once part of the range of the Hooded Plover, but they were gone from these areas by the 1920s (Cameron and Weston 1999). The Hooded Plover has not been seen north of Sydney since the 1940s (Hindwood and Hoskin 1954, Cameron and Weston 1999). McAllan (2001) has challenged the extent of the range contraction.

In South Australia, Hooded Plovers have been sighted from the eastern edge of the Great Australian Bight (Fowlers Bay area) through to the SA/Victorian border. Birds have not been recorded in the upper reaches of the Spencer Gulf or St Vincent's Gulf. Hooded Plovers have also been located at several non-coastal sights, including Lake Malata, Lake Greenly and Lake George (refer to Figs. 1-3).

1.5 Populations

There are about 3,000 Hooded Plovers in eastern Australia and 4,000 in the west (Garnett and Crowley 2000). The total population in South Australia is about 540 birds (Natt and Weston 1995). There are at least 470 and probably 600 in Victoria (Murlis 1989, Weston 1995, 2003), about 1,700 in Tasmania (Newman and Patterson 1984, Holdsworth and Park 1993), and about 60 in New South Wales (Morris 1989).

Densities south of Narooma (NSW) to the Victorian border of around 0.6 birds per km are similar to those throughout Victoria (0.7 birds per km). Victorian populations have been generally stable over recent years (Murlis 1989), with wide variation in counts between years due to weather conditions during surveys, though there has been a decline during 1980 and 1992 between Westernport and Wilson's Promontory (Weston 1993) and on Phillip Island (Baird and Dann 2003). Bransbury (1991) recorded 1.6 birds per km on Kangaroo Island! See Dennis and Masters 2006 for updated data, but only 0.5 per km in south-east South Australia (Bransbury 1983). Kangaroo Island is home to about one-third of South Australia's Hooded Plovers, and over the last 20 years the population there has declined by c.24%, with greatest declines (44%) on the eastern and northern coasts where there is greatest human disturbance (Dennis and Masters *2006*). Similar declines and some local extinctions occurred on highly disturbed Tasmanian beaches during 1988-96 (Woehler and Park 1997). Densities of Hooded Plovers are highest on the coasts of Tasmania (Schulz and Menkhorst 1984) and western Victoria (Murlis 1989, Weston 1993) at 3.5 - 4.4 birds per km.

Figure 1: Records of Hooded Plover *(Thinornis rubricollis)* on the west coast of South Australia. Records are from the DEH Biological Database of SA and the SA Museum. Records are grouped in time periods, with more recent records overlaying older records.

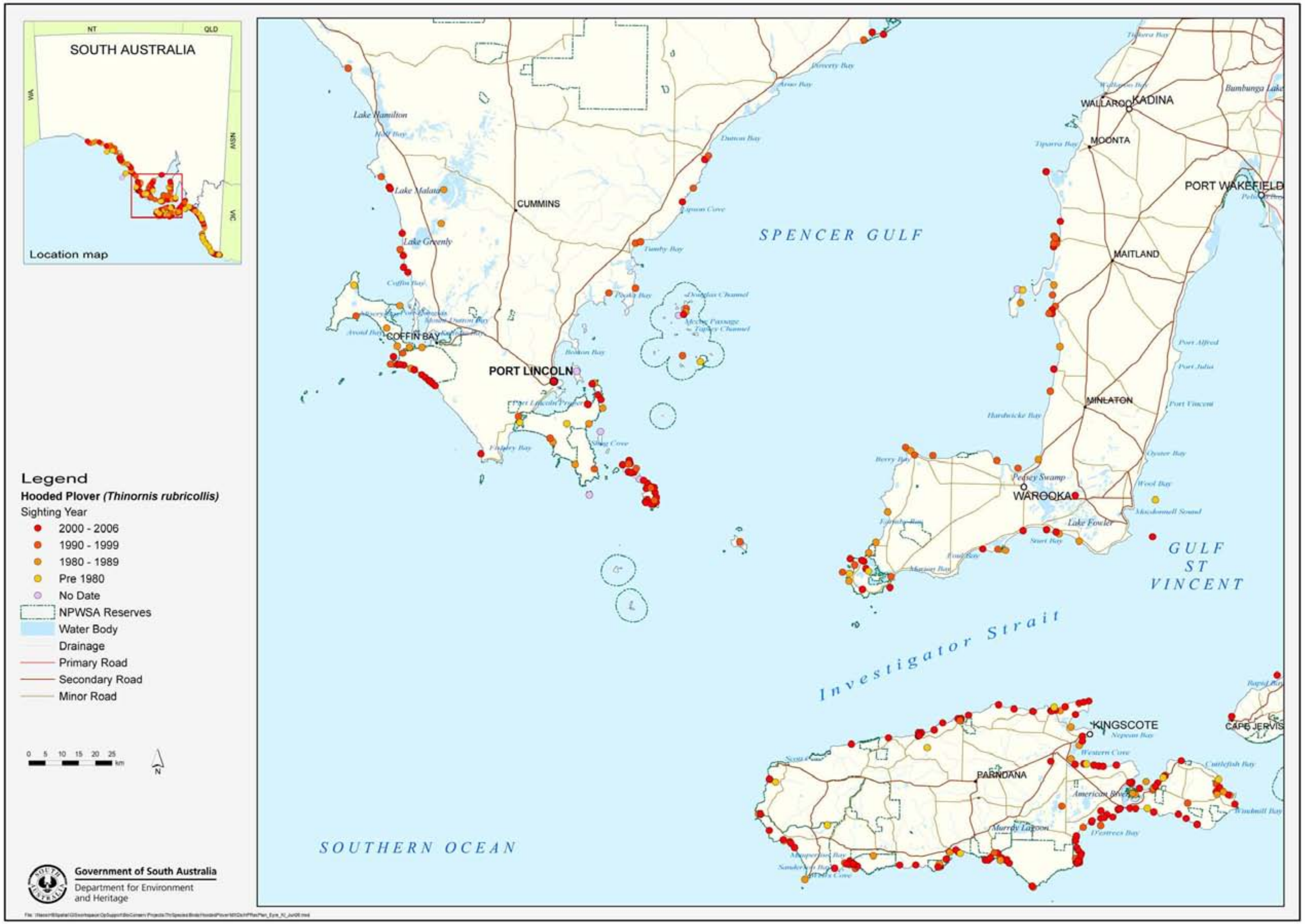


Figure 2: Records of Hooded Plover *(Thinornis rubricollis)* on Eyre Peninsula, Yorke Peninsula and Kangaroo Island, in South Australia. Records are from the DEH Biological Database of SA and the SA Museum. Records are grouped in time periods, with more recent records overlaying older records.

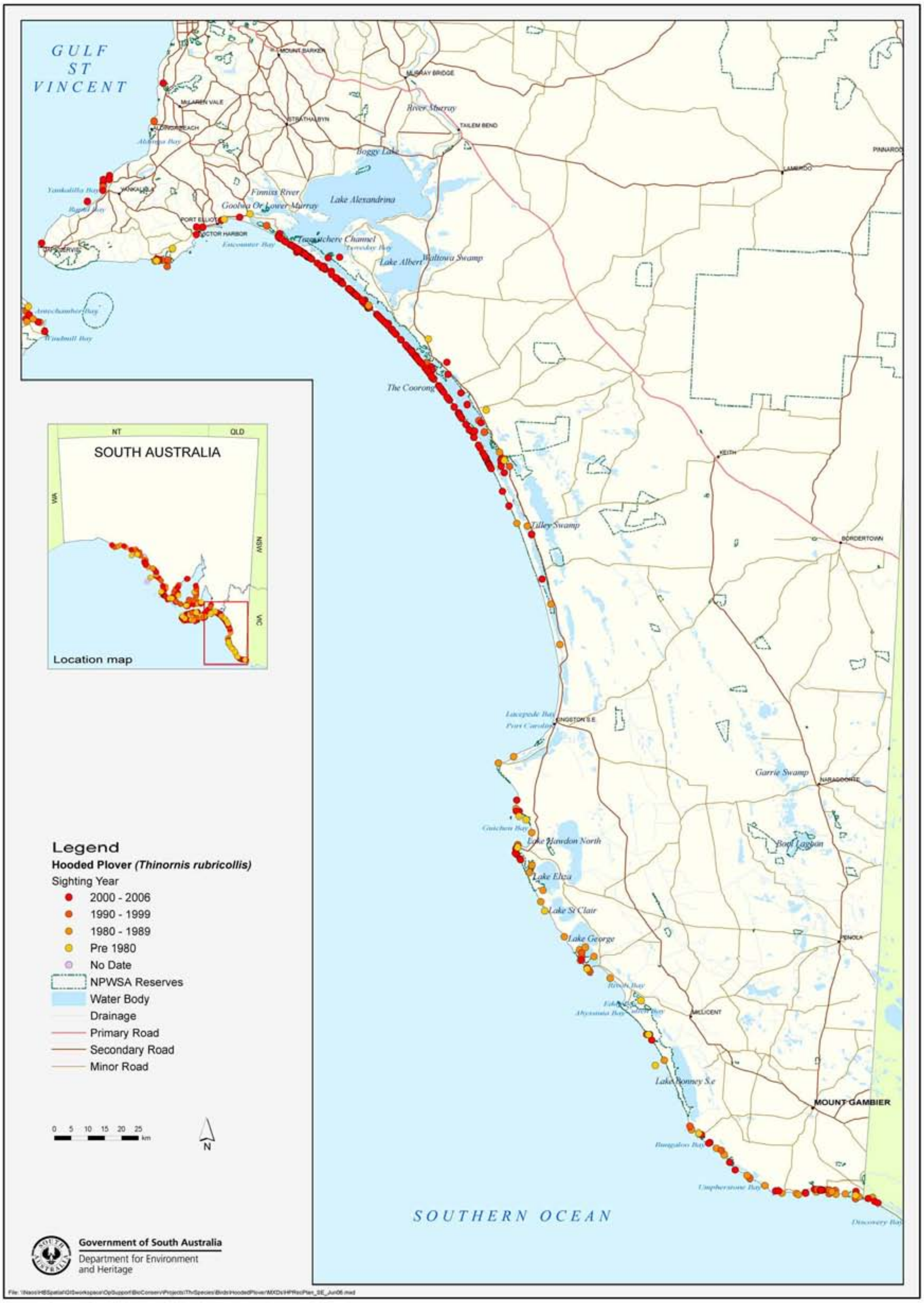


Figure 3: Records of Hooded Plover *(Thinornis rubricollis)* on the Fleurieu Peninsula and south east coast of South Australia. Records are from the DEH Biological Database of SA and the SA Museum. Records are grouped in time periods, with more recent records overlaying older records.

1.6 Population surveys and monitoring

The Australasian Wader Studies Group (AWSG), a special interest group of Birds Australia, has coordinated a volunteer-based national Hooded Plover survey every two years during the breeding season since 1980 (see Weston 1993). Weston (2003) calculated that because the rate of population change is slow, there is little benefit to be gained from increasing surveys from once every two years to annual surveys. Biennial counts have an established organisational structure, are cost-effective, and are reliable. Processes are already in place for data collection, data entry and information dissemination. Weston (2003) advocated some methodological improvements to the biennial counts such as the widespread use of Global Positioning System (GPS) units, and conducting an additional post-breeding biennial count to estimate breeding success.

1.7 Habitat critical for survival

Habitat critical for survival needs to contain all known sites for breeding, food resources, water, shelter, essential travel routes, dispersal, buffer areas, and sites needed for future recovery as defined by the EPBC Act 1999. The habitat critical to the survival of the Hooded Plover is described in section 1.8 and is defined in this Recovery Plan as all potential habitat within its 'current normal range'. Most of the habitat is on public land.

1.8 Habitat

In south-eastern Australia Hooded Plovers prefer sandy ocean beaches, especially those that are broad and flat, with a wide wave-wash zone for feeding, much beachcast seaweed, and backed by sparsely vegetated sand-dunes for shelter and nesting (Smith 1964, Lane 1981, Schulz *et al* 1984, Murlis 1989, Weston 2003). In south-east South Australia and Kangaroo Island, Stephens (2004) found that breeding sites were mostly associated with beaches that were less than 10 km long and 20 m wide, with more headlands and complex dune systems, and remote from settlements and sites frequented by walkers, fishers and dogs. On Kangaroo Island, only *c.*50 km (10%) of the coastline was occupied by Hooded Plovers during 1985-2004 (Dennis and Masters*2006*). They generally avoid narrow, steep beaches with little seaweed and waves washing up to the base of the dunes. They also tend to avoid beaches where backing dunes are absent, bare, or heavily vegetated; extensive rocky or pebble-covered shores and coasts with continuous cliffs (Lane 1981, Bransbury 1988, Hewish 1989, Schulz 1990), though around Cape Otway they are commonly found on small beaches surrounded by long lines of cliffs (MA Weston pers. comm.). Hooded Plover chicks rely heavily on fore-dunes and dunes as their main site of concealment from potential predators (Weston and Elgar 2005). Occasionally Hooded Plovers are found on tidal bays and estuaries, rock platforms and rocky or sand-covered reefs near sandy beaches, and small beaches in lines of cliffs (Schulz 1986, Bransbury 1988, Hewish 1989, Weston and Peter 2004). Hooded Plovers regularly use near-coastal saline and freshwater lakes and lagoons, often with saltmarsh, though the importance of this habitat is not well known (Thomas 1968, Bransbury 1988, Marchant and Higgins 1993).

Hooded Plovers obtain their annual life cycle needs from ocean beaches, foraging in sand at all levels of the zone of wave wash during low and mid-tide or among seaweed at high-tide, and occasionally in dune blowouts after rain (Reed 1975, Schulz *et al* 1984, Marchant and Higgins 1993). At night they favour the upper zones of beaches (Schulz 1984). When on rocks they forage in crevices in the wave-wash or spray zone, avoiding elevated rocky areas and boulder fields (Schulz 1986, Lane 1987, Marchant and Higgins 1993). However, at some area they routinely forage in boulder fields (MA Weston pers. comm.). When at coastal lagoons they forage in damp or dry substrates and in shallow water, depending on the season and water levels (Marchant and Higgins 1993).

On beaches Hooded Plovers roost, loaf or shelter mainly in the upper beach zones, often next to hummocks of beachcast seaweed, rocks, and other debris (Schulz 1984, Reed 1975, Bransbury 1988, Hewish 1989). They may also roost in dunes and, occasionally, on sandbars (Reed 1975, Bransbury 1988).

In eastern Australia, Hooded Plovers usually breed on sandy ocean beaches strewn with beachcast seaweed, in a narrow strip between the high-water mark and the base of the fore-dunes. They often nest within 6 m of the fore-dune, mostly within 5 m of the high-water mark, but occasionally among or behind dunes (Reed 1975, Lane 1981, 1987, Bransbury 1988, Buick and Paton 1989, Marchant and Higgins 1993). However, dunes have been under-rated as a breeding habitat for Hooded Plovers because nests are harder to locate there, and most observers confine their activities to the beach. At Mornington Peninsula National Park, Victoria, 33% of nests were in the primary dune (Dowling and Weston 1999) and on the Bellarine Peninsula, Victoria, during 1995-98, most nests were in the dunes (MA Weston unpubl). Nests are sometimes found hundreds of metres from the beach, as are broods and flocks roosting in large dune blowouts (Weston 1998a, MA Weston unpubl). Further evidence of the importance of sandy dunes comes from a section of the Tasmanian coast where Hooded Plovers can no longer nest because of the use of marram grass *Ammophila arenaria*, for erosion control (Park 1994). The introduced sea spurge *Euphorbia paralias* which colonises primary dunes may have a similar impact (Schulz 1992).

1.9 Movements

In south-eastern Australia, some movement occurs in the autumn-winter non-breeding season with birds absent from or sparse in several sites where they breed in spring-summer (Bransbury 1985). Hooded Plovers and their broods move up to 2 km in a day (Weston 2000). Hooded Plovers occasionally move small distances inland, particularly in winter, to salt lakes immediately behind beaches (Blakers *et al* 1984). They can also cross considerable stretches of water, with three colour-banded birds known to have moved across the 16 km of open sea in Backstairs Passage, separating Kangaroo Island from the mainland (T Dennis and MA Weston pers. comms). Recent colour-banding studies indicate that the movements of breeding adults and juveniles has been considerably underestimated, with some juveniles moving over 100 km (MA Weston and T Dennis unpubl. data), and one extreme case of a juvenile moving at least 900 km (Cameron and Weston 1999). Hooded Plovers may breed considerable distances from their natal territory, or they may bred nearby (Dowling and Weston 1999, Weston 2000).

1.10 Diet

Hooded Plovers feed on a wide range of polychaetes, molluscs, crustaceans, insects, turions and seeds (Schulz *et al* 1984, Schulz 1986). One prey that seems particularly important in salt-lakes are gastropods in the genus *Coxiella* (MA Weston unpubl.). They forage diurnally and nocturnally on beaches, especially in wave-wash, lagoons and saltpans. Paired birds do not usually forage more than 500 m from their nest (Buick and Paton 1989), but may forage in sub-coastal wetlands rather than on the beach adjacent to the nest (MA Weston pers. comm.).

1.11 Population structure and activity patterns

Hooded Plovers are seen singly, in pairs, family groups or small flocks (Buick and Paton 1989, Marchant and Higgins 1993). During winter, very few birds are in pairs (Schulz 1987), and flocks of 30-40 birds, and rarely 100 birds, occur on some beaches in the south-eastern States (Marchant and Higgins 1993, Weston 1998a). Aggression is common in flocks or when pairs defend territories from intruders (Weston 1998a). Interspecific aggression has been directed at a range of waders, two species of gull, and even at some beach-inhabiting passerines (Marchant and Higgins 1993, Weston 1998b).

Hooded Plovers breed in single pairs with 70-80% of birds in pairs during summer (Buick and Paton 1989, Weston 1993). They have high nest site fidelity and nest solitarily. On mainland Australia, nests may be 2-5 km apart (Buick and Paton 1989, Bransbury 1991), with breeding densities sometimes more than double this on Tasmania and Kangaroo Island (Marchant and Higgins1993). From August to March, clutches of 2-3 eggs (one and four egg clutches have been recorded) are laid in a depression in the sand that may or may not be lined with pebbles, fragments of shell and seaweed (Morris *et al* 1981, Marchant and Higgins 1993, Weston *et al* 1998). Incubation begins in earnest once laying is completed (Weston and Elgar 2005b). Both birds incubate for a total of 27-28 days (Bransbury 1991), although incubation periods of up to 31 days have been recorded (Tomkovich and Weston *In press*). Birds incubate for extended periods, the most common uninterrupted bout duration being 25 minutes (Weston and Elgar 2005b). Hatching success is low at around 27% of eggs laid and only 0.1 young fledge per pair (Buick and Paton 1989, Marchant and Higgins 1993). The young leave the nest shortly after hatching and accompany the adults until they fledge 33-36 days later (Newman 1986, Marchant and Higgins 1993). Occasionally they may remain until a subsequent nest is laid (Whitelaw *et al.* 2005). Hooded Plovers may breed when a little over one year old. It is not known how long they live in the wild, though they are probably long-lived, with two banded birds being more than ten years old (Weston 2000, MA Weston unpubl). In the closely-related Shore Plover mean longevity is six years, with some birds living for at least 17 years (Marchant and Higgins 1993).

The sex ratio of adults and juveniles in Victoria approximates parity (Weston *et al.* 2004).

If an avian predator flies over a nest then the sitting bird often stays on the nest, but if a terrestrial predator such as a fox or dog approaches, the bird runs rapidly from the nest and waits near the surf zone or walks ahead of the predator until it is 100-300 m from the nest. The Hooded Plover then runs or flies back along the water's edge (Schulz 1988, Bransbury 1991). Buick and Paton (1989) observed that incubating birds remained on the nest if vehicles passed more than 20 m from them, but occasionally left the nest if they came closer than 20 m. People on a beach caused incubating birds to leave the nest on 70% of occasions. Birds leave the nest when a person is 150-200 m away early in the incubation period and when they are 50-60 m away just before hatching (Buick and Paton 1989). They remain off the nest for varying periods, averaging 232 s (93-330 s) when disturbed by walkers and 207 s (62-632) when disturbed by vehicles (Buick and Paton 1989, Bransbury 1991). Weston and Elgar (2005a) have described the response of incubating birds to disturbance in Victoria. There, a range of stimuli caused birds to leave the nest, and the response to disturbance was mediated by stimulus type and the habitat in which the nest was located. If an intruder stops near their nest, Hooded Plovers may crouch or sit as if on a nest. Parents may feign injury to lure predators away from fledglings, distraction displays being rare during the egg-phase (Marchant and Higgins 1993, Weston and Elgar 2005b).

The incubation temperature of most avian species lies between 35 – 38℃ (mean = 37.5℃) which is close to the upper lethal temperature tolerated of 42 – 48℃, depending on the age of the embryo (Drent 1975). Drent (1970) found that on a sunny 18℃ morning the internal temperature of an abandoned Herring Gull *Larus argentatus* egg reached 44℃ within two hours and exceeded the lethal limit. Where air temperatures are higher, the risk to the embryo is far greater, and the time to reach the lethal limit is much shorter (Drent 1975). Even under uninterrupted incubation, Hooded Plover egg temperature varies to some extent with ambient temperature (Weston and Elgar 2005b). However, disturbance-caused absences cause greater thermal variation in eggs than absences when the parents choose to leave the nest (Weston 2000). Temperatures from false eggs suggest thermal upper lethal limits are at least sometimes exceeded during disturbance. The fact that egg mortality rates reflect the pattern in response rates and durations in different habitats suggests that disturbance causes some reproductive failure (Weston 2000).

2 THREATS

Many of the disturbances faced by Hooded Plovers are common to other beach-nesting birds. However, the Hooded Plover has a long incubation and fledgling period of nearly two months, as well as being much shyer than some beach-nesting birds, making it more vulnerable than most (Schulz 1992). Most threats have an impact on reproductive success rather than flying birds. Threats that are probably insignificant (Weston 2003) are not listed below. While breeding failure is common in Hooded Plovers, they can re-nest and thus compensate for the loss to some extent. On the other hand, the death of flying birds is more problematic at the population level because the birds are difficult to produce and have the potential to breed for many years (Weston 2003).

Across South Australia, five threats are likely to have high impacts on Hooded Plovers relative to other risks. These threats are: humans, dogs, vehicles, introduced predators, and habitat modification. Another potential threat includes silver gull predation due to increased numbers in the south east of South Australia (I Stewart pers. comm.).

2.1 Humans and their companion animals (*Major threat*)

The Hooded Plover's nesting season extends from August to March, which includes the peak time of beach use by holiday-makers (Baird and Dann 2003). Moreover, populations of humans in many coastal towns have increased greatly. Hence the species is often disturbed by recreationists and their dogs, and its eggs and chicks are frequently crushed by residents as well as holiday beach users(Schulz 1992, Schulz and Bamford 1987, Dowling and Weston 1999).

The bird's habit of leaving the nest and not returning until people and their dogs have left the area has an important influence on breeding success (Schulz 1992, Dowling and Weston 1999, Weston 2000a). While the parent is absent the eggs or chicks are vulnerable to predators such as gulls (*Larus* spp) and ravens (*Corvus* spp) and to high temperatures (Weston 2000a, Weston and Elgar *in press*). At Mornington Peninsula National Park in Victoria, Dowling and Weston (1999) found that 30% of nests were trampled by recreationists. In western Victoria 20% of nests were at a high risk from crushing, being close to human access points (Weston and Morrow 2000). Incubating Hooded Plovers left their nests on 91% of 580 occasions when they were exposed to a disturbance, and three-quarters of those disturbances on central Victoria beaches were from humans and their companion animals (Weston and Elgar *in press*). Leashed dogs caused no more disturbance than unaccompanied humans, presumably because they moved slowly and predictably along the mid-beach. Unleashed dogs were highly disturbing, probably because they tended to move more rapidly up and down the beach perpendicular to the water's edge, and because they pursued Hooded Plovers at times (Weston and Elgar *in press*).

Weston and Elgar (2005) found that brood-rearing Hooded plovers spent 12% of their time responding to disturbance and that over 80% of disturbances were caused by humans. Encounters with humans often caused brooding to stop and almost always ended foraging, exposing the chicks to temperature and food stresses that could have an impact on chick survival (Weston and Elgar 2005). Nevertheless, Hooded Plovers can sometimes breed successfully on beaches that are regularly visited (Marchant and Higgins 1993). Indeed, appropriate management seemed to increase breeding success in the very heavily used Mornington Peninsula National Park in Victoria (Dowling and Weston 1999). There seems to have been a coincident increase in the population size in the park (B. Dowling unpubl). At popular Phillip Island in Victoria, only one of 12 nests were successful in 1982, the rest failing due to disturbance (Lane 1987). With the deployment of nest protecting cages hatching success was substantially increased (Dann and Baird 1997), and volunteer wardening further increased breeding success to seven flying young from 14 nests in 1998 (P Dann pers. comm.).

2.2 Vehicles on beaches (*Major threat*)

Vehicles driving along beaches can have a major impact on breeding success, particularly in South Australia where this is generally permitted (Buick and Paton 1989, Garnett 1992). The growing number of off-road vehicles has resulted in increased recreational driving on isolated stretches of coastline where the birds previously lived undisturbed (Schulz and Bamford 1987). Hooded Plover densities are more than twice as high in western Victoria as they are in neighbouring parts of South Australia (Lane 1987, Lane 1990), suggesting that the effect of vehicles on the status of the species is significant. Victorian legislation that prohibits driving on beaches may result in increased driving on beaches in nearby parts of South Australia because over 60% of vehicles on the beach at Little Dip National Park in neighbouring South Australia had Victorian number plates (Coxon 1997). Stephens (2004) found higher densities of Hooded Plovers on beaches in south-east South Australia and on Kangaroo Island that had low vehicle use, and Dennis and Masters (*2006*) reported greatest declines on Kangaroo Island's beaches where vehicles have unregulated access. At the Coorong in South Australia, 81% of nests in one year were run over by vehicles (Buick and Paton 1989). In western Victoria, illegally driven vehicles crushed 18% of nests (Weston and Morrow 2000). Chicks may also shelter in wheel ruts and up to 30% on the Coorong are crushed (Buick and Paton 1989). As a result of this information, for over a decade about 110 km of the northern end of the Coorong has been closed to vehicles from 24 October to 24 December each year, specifically to protect the Hooded Plover (SA Government 1993). A small number of commercial vehicles use the northern Coorong under permit. Nocturnal driving on beaches in poor weather is also known to kill adults (MA Weston pers. comm.).

Although the major recorded impact of disturbance of people and vehicles is on breeding success (eg Weston 2003), Stephens (2004) found that the highest concentrations of non-breeding Hooded Plovers were also on the least disturbed beaches. Citing overseas studies of shorebirds (eg Lafferty 2001), Stephens (2004) postulated that frequent short flights to avoid disturbances are energetically costly, reduce foraging time, deplete fat stores and lower survival rates of non-breeding birds.

2.3 Introduced predators (*Major threat*)

The introduced fox and uncontrolled domestic dogs are known to eat eggs and young Hooded Plovers (Stewart 1989, Whiter 1991, Dowling and Weston 1999). Dowling and Weston (1999*)* found that 2% of nests were predated by foxes in an area where control programs had been implemented, and up to 27% of nests where foxes were not controlled (Weston 2003). Even though urban development can encourage fox densities three or more times greater than in rural Australia (Coman *et al.* 1991, Marks and Short 1996), it is in relatively pristine areas that foxes become the dominant local threat to mainland Hooded Plover populations (Weston 2003). Fox control for Hooded Plover management has been initiated in some coastal national parks in Victoria. Counts have been conducted to determine the effectiveness of baiting, but they do not provide conclusive evidence in the absence of contemporary studies of breeding success such as those at Mornington Peninsula. Fox-baiting combined with temporary beach closure on the northern Coorong is thought to have increased the numbers of Hooded Plovers, eggs and chicks located during surveys (Hockley 2000, Weston 2003). Note however, that Kangaroo Island has no foxes and densities of Hooded Plovers have declined there by c.24% over the last 20 years (Dennis and Masters *2006*), with greatest declines (44%) on the most highly disturbed beaches.

Domestic dogs chase adults (Retallick and Bolitho 1993, Weston and Morrow 2000) and have been seen mauling (Weston 1998c) and killing chicks (B. Baird pers comm.). At Mornington Peninsula National Park, Victoria, enforcement of dog laws can significantly increase compliance, though overall compliance remains low (Dowling and Weston 1999).

Cats *Felis catus* and rats *Rattus* sp. have been recorded preying on Hooded Plover nests (Hanisch 1998) and cats may kill adult birds (Weston 2003). The impacts of these nocturnal predators, which occur on Kangaroo Island and some other offshore islands, are difficult to assess.

2.4 Habitat modification (*Major threat*)

Erosion control in dunes is widespread in south-eastern Australia, and generally consists of planting species of grass or covering exposed dunes with branches, with the result that fore-dunes can become vegetated and steeper (Park 1994, Weston 2003). Erosion control has permanently removed some Hooded Plover breeding habitat, because steep, heavily vegetated dunes are unsuitable for nesting (Park 1994, Weston 2003). Dune blowouts are a major part of Hooded Plover breeding habitat in some areas, and the re-colonisation of such areas can threaten some pairs' breeding success (Weston 2003).

Kelp and seaweed harvesting may disturb birds, destroy nests and kill chicks, and reduces food availability (Schulz 1992, Weston and Morrow 2000). If kelp harvesting is to take place it should only take place during the non-breeding season.

Sheep have unrestricted access to beaches along much of Kangaroo Island's northern coastline and feral goats are frequently recorded grazing on fore-dune vegetation and on beaches on the western coastline in Flinders Chase National Park (Dennis and Masters *2006*). Hooded Plovers on Phillip Island in Victoria have abandoned their territories when trampled by sheep (Baird and Dann 2003).

2.5 Communication gaps (*Moderate threat*)

Most of the threats from humans and their companion animals can be addressed by education and effective communication, supplemented in some areas with well-planned infrastructure such as fencing beach access points. A large number of brochures, posters, cards, and interpretive signs on Hooded Plovers have been used in coastal areas and these methods and their relative effectiveness are described by Weston (2003). Additional interpretive material has become available in recent years (MA Weston pers. comm.), and information on its effectiveness is growing (e.g. Dodge *et al.* 2005). Wildlife agencies and volunteers have played important roles in distributing information on Hooded Plovers, but there are still many gaps in the distribution network. Moreover, the variation in occurrence and impact of threats, such as vehicles on beaches, means that managers face complicated decisions about what threats to manage, where to manage them, and what communication messages to broadcast in particular areas. A combination of communication approaches and management strategies has been found to be effective in highly visited areas (Weston and Dowling 1999), but even then some messages such as the need to keep dogs on leashes have very low rates of compliance. Shorebird conservation projects in Australia vary in their success at increasing awareness, and careful planning and a commitment to communicating characterises the most successful efforts (Antos *et al. in press*).

2.6 Flooding of nests (*Moderate threat*)

Inundation of nests by high tides appears to be an important cause of loss of beach-nesting birds' clutches (McGarvie and Templeton 1974, Murlis 1989, Stewart 1989), but Dowling and Weston (1999) and Weston (2000a) found that only 2% of 295 nests were flooded in Victoria. About 7% of 79 nests were flooded in Tasmania (Hanisch 1998, Weston 2003). Flooding of nests may become more frequent as sea levels rise.

2.7 Information gaps (*Moderate threat*)

Weston (2003) identified 14 areas of research needed to address information gaps. Of the six highest priorities, two focus on the species: determining the causes of chick mortality, and the effectiveness of artificial shelters for chicks. Two high research priorities that focus on breeding habitat are: habitat factors influencing territory stability, and developing methods for rehabilitating dunes colonised by invasive dune-stabilising plants. The two highest research needs that focus on management are: compliance with dog laws, and determining the effectiveness of predator control. All of these high priority topics will be studied as part of postgraduate research at Deakin University in Victoria in 2006-07 (Birds Australia 2006).

2.8 Oil spills (*Minor threat*)

Oil spills have the potential to have a major local impact on adult Hooded Plovers (Schulz and Bamford 1987). Although the likelihood of an oil spill is low, the threat can be reduced by ensuring that there is a plan in place to contact and employ suitably qualified and experienced Hooded Plover trappers in the event of a spill, and to deliver birds to an Oil Spill Response Team for treatment. In previous oil spills, the care and rehabilitation of Hooded Plovers has been neglected in favour of caring for higher numbers of common species such as the Little Penguin *Eudyptula minor*. In south-eastern Australia, the Hooded Plover and the Little Tern *Sterna albifrons*, as threatened species, should receive priority in any oil spill treatment. Oiled Hooded Plovers have been successfully trapped, cleaned and released in a Victorian oil spill (MA Weston unpubl.).

3 RECOVERY OBJECTIVES AND TIMELINES

3.1 Overall Objective

To demonstrate within five years a reversal of recent population declines, and to initiate longer-term measures designed to achieve a down-listing in South Australia from Vulnerable to Conservation Dependent.

3.1.1 Primary Recovery Actions

Primary Recovery Actions are necessary to provide a broad knowledge base on which to proceed with Secondary Recovery Actions.

1. Establish current baselines on the following:

a). Hooded Plovers

General distribution: the extent of occurrence and area of occupancy;

Specific distribution: on which beaches they do (?) and do not (?) occur; geomorphic occurrence (what types of beaches they occupy); which regions/districts have reliable data.

b). Threats

Establish/Define relative threat baselines (i.e. zones, e.g. baited vs unbaited; dogs vs no dogs; vehicle access; weeds);

Ascertain the extent of occurrence of habitat modification (i.e. erosion control, invasive plants, extractive processes, coastal development).

2. Identify gaps in knowledge/data

distribution – general and nesting

relative recruitment rates

movements, e.g. from islands to mainland

different threats

3. Identify key locations for long-term monitoring based on:

ease of access/proximity to regular observer(s)/reliability of observers

different threat zones (even spread if possible) (target specific beaches)

different management regimes (target specific areas)

4. Analyse available data to determine site-specific/district/region/state SMART targets

5. Ensure Recovery Plan remains relevant through regular review processes

6. Establish/Identify monitoring network members by area – seek their feedback/comments on draft maps and Recovery Plan

7. Develop monitoring (and extra survey) protocols and test-run them.

To deal with threats to the Hooded Plover and thereby improve its status within five years by:

Increasing recruitment success (e.g. on KI)

Increasing total population size;

Reversing recent declines in extent of occurrence;

Improving management of people, vehicles, and introduced predators on beaches;

Increasing community awareness and involvement;

Implementing the Recovery Plan through a Recovery Team.

4 SECONDARY RECOVERY ACTIONS:

4.1 Threat Abatement Objective

Increase Hooded Plover numbers by increasing nesting success, through introducing strategies to mitigate the impacts of humans and their companion animals on selected beaches, and modifications to habitat.

4.1.1 Performance criterion

Improve Hooded Plover numbers by reversing current trends in recruitment success, based on the results of 3.1.1. 1.b).

Actions

(a) Map and prioritise the current and historical distribution of Hooded Plovers and record each area's disturbance regimes and other threats.

(b) Develop appropriate management strategies for selected sites, as undertaken for national parks and reserves in Victoria by Weston (2003).

(c) Liaise with beach-user groups, government agencies, local planning authorities, and other relevant groups.

(d) Integrate threat abatement strategies into reserve and regional plans to help reverse indiscriminate use of important Hooded Plover habitat.

(e) Work with local government representatives and managers of coastal reserves to ensure that they are aware of the need to exclude uncontrolled dogs from important Hooded Plover breeding sites.

(f) Develop appropriate management strategies to address habitat modification identified in 3.1.1.1.b).

4.2 Threat Abatement Objective

Increase Hooded Plover numbers by increasing nesting success through implementing strategies to deal with vehicles crushing nests and chicks on beaches.

4.2.1 Performance criterion

Improve Hooded Plover numbers by increasing nesting success, through increasing the number of beaches with restricted vehicle access over the next five years.

Actions

(a) Continue the breeding season closure of the northern Coorong to vehicles.

(b) Implement temporary beach closures for vehicles on other high priority beaches, particularly in national parks or where complimentary threat mitigation activities are implemented.

(c) Train drivers of management vehicles that require beach access to only drive at low tide and to adhere to the lower half of the beach.

(d) Investigate alternatives for vehicle access or closures to beaches.

4.3 Threat Abatement Objective

Increase Hooded Plover numbers by increasing nesting success, through expanding strategies to combat introduced predators.

4.3.1 Performance criterion

A system of managed and baited areas reduces the number of key sites that are heavily impacted by foxes during the Hooded Plover breeding season.

Actions

(a) Implement and monitor control programs for foxes near Hooded Plover breeding sites, noting that foxes may be the sole major threat in remote areas.

(b) Keep abreast of developments to protect breeding shorebirds from introduced predators such as nest cages and fencing, and implement those that are appropriate.

4.4 Objective

Help fill information and data analysis gaps on the relative abundance and distribution of Hooded Plovers and their biological requirements.

4.4.1 Performance criterion

Trends in relative abundance of Hooded Plovers are monitored every year and analysed, and new information is incorporated into management strategies.

Actions

(a) Assist the Australasian Wader Study Group to conduct their established volunteer-based biennial national survey of Hooded Plovers, and their new survey of breeding success through counts of flying young.

(b) Support the publication of all shorebird count data from South Australia.

(c) Keep abreast of new studies on Hooded Plover management by holding a workshop with participation by relevant interstate experts and attend interstate workshops as well.

4.5 Objective

Increase (1) community involvement and (2) community awareness in the conservation of the Hooded Plover and its needs.

4.5.1 Performance criterion

An increase in the number of (1) people involved in and (2) aware of the recovery program, and (3) an increase in the area outside reserves managed sympathetically for the Hooded Plover.

Actions

(a) Develop a communication strategy that identifies the ways in which people can be made aware of threats to Hooded Plovers and how they can become involved in a range of actions that are planned for different areas of the coast.

(b) Provide information to beach-user groups, government agencies, local planning authorities, oil spill response teams, and other relevant groups.

(c) Use existing templates for community awareness packages (e.g. Weston 2003), signs on beaches and direct communication with beach-user groups.

(d) Involve community volunteers in wardening Hooded Plover nests at selected disturbed sites, e.g. Fleurieu Birdwatch Group volunteers at Encounter Bay.

(e) Support training of volunteer participants in Australasian Wader Studies Group surveys and activities such as wardening.

(f) Provide regular feedback on progress and improvements to management regimes to community groups, participants, agencies and local authorities.

(g) Employ a part-time Shorebird Co-ordinator to develop management strategies for selected beaches, organise workshops, liaise widely, involve and train volunteers, provide feedback, and develop a communication strategy.

4.6 Objective

Implement the Recovery Plan through a Recovery Team.

4.6.1 Performance criteria

Successful operation of the recovery program over five years.

Actions

(a) Establish a recovery team with appropriate stakeholder representation.

(b) Guide and review the recovery program.

(c) Ensure the recovery team functions efficiently and communicates well.

(c) Report on progress against objectives and performance criteria.

(d) Undertake an external review of the recovery program after four years.

5 BIODIVERSITY BENEFITS

Many of the disturbances faced by Hooded Plovers are common to other beach-nesting birds (Schulz 1992, Birds Australia 2006). The Hooded Plover could become a ‘flagship' species in the effort to conserve threatened shorebirds in south-eastern Australia (Birds Australia 2006). Hooded Plovers commonly occur and breed in or near the same areas as endangered Little Terns and Fairy Terns in South Australia. They may also occur in the same areas as declining resident shorebirds, and migratory shorebirds listed under the Japan Australia Migratory Bird Agreement and the China Australia Migratory Bird Agreement, e.g. sanderlings.

Many of the actions in this Recovery Plan, such as fox control, dog exclusion and community information programs will benefit a range of coastal species including those living in nearby parks and reserves.

6 COSTS OF THE RECOVERY PLAN

Many of the core tasks have been allocated to a part-time (c. $40,000 pa) Shorebird Co-ordinator. This is a key position for this recovery plan to work efficiently and effectively.

Action	Cost estimate $,000 pa	Responsibility	Timeframe
4.1 Reduce human & companion animal impacts			
4.4.1. (a) Map distribution and disturbance	10	Co-ordinator	Year 1
4.1.1. (b). Develop site-specific strategies	15	Co-ordinator	Year 2
4.1.1. (c). Liaise with groups	5	Co-ordinator & NPWS	Ongoing

4.1.1. (d). Integrate strategies into other plans	5	NPWS & Co-ordinator	Years 1-5
4.2. Reduce vehicle impacts			
4.2.1. (a) Continue Coorong seasonal closure	-	NPWS	Ongoing
4.2.1. (b) Implement other temporary beach closures	-	NPWS	Years 1-5
4.2.1. (c) Train management drivers	-	NPWS	Year 1
4.3. Control predators			
4.3.1. (a) Exclude uncontrolled dogs from key sites	-	NPWS & Local Govt	Ongoing
4.3.1. (b) Control and monitor foxes at key sites	-	NPWS	Years 1-5
4.3.1. (c) Keep abreast of developments	-	Co-ordinator	Ongoing
4.4. Monitor populations			
4.4.1. (a) Assist AWSG biennial counts	5	Co-ordinator & NPWS	Years 2 & 4
4.4.1. (b) Support publication of AWSG data	-	NPWS	Years 1 & 5
4.4.1. (c) Workshop new developments	5	Co-ordinator	Year 3
4.5. Community involvement			
4.5.1. (a) Develop a communication strategy	15	Co-ordinator	Year 3
4.5.1. (b) Provide information to groups	5	Co-ordinator	Ongoing
4 5.1. (c) Use community awareness packages	5	NPWS & Co-ordinator	Ongoing
4.5.1. (d) Involve volunteers in wardening	5	NPWS & Co-ordinator	Years 1-5
4.5.1. (e) Support volunteer training	-	AWSG	Ongoing
4.5.1. (f) Provide feedback to groups	5	Co-ordinator	Ongoing
4.5.1. (g) Employ a part-time Shorebird Co-ordinator	See above	NPWS	Years 1-5
4.6. Implement the Recovery Plan			
4.6. 1 (a) Establish a recovery team	-	Recovery Team	Year 1
4.6.1. (b) Guide and review the recovery plan	-	Recovery Team	Ongoing
4.6.1. (c). Ensure efficiency	-	Recovery Team	Ongoing
4.6.1. (d) Report on progress	-	Recovery Team	Years 1-5
4.6.1. (e) Review Recovery Plan	5	Consultant	Year 4

Summary of Costs

	Year 1	Year 2	Year 3	Year 4	Year 5
Total	$45,000	$55,000	$55,000	$45,000	$40,000

7 MANAGEMENT PRACTICES THAT MAY HAMPER VIABILITY AND RECOVERY

- Failure to develop and effectively promulgate site-specific strategies.
- Inadequate cooperation secured from beach-user groups.
- Successful opposition to further temporary closures of select beaches to vehicles.
- Failure to reduce feral predator impacts at key sites.
- Coastal land-use changes that increase disturbance at key beaches.
- Lack of training and support for volunteers.
- Insufficient funds to implement recovery actions.

8 MONITORING, REPORTING AND REVIEW

Progress will be monitored and evaluated yearly by members of the Recovery Team through an annual review. The monitoring process will include:

- Compiling information and data, assessing progress made for all actions with the criteria and objectives of the Recovery Plan in mind.
- There will be an external review after four years of Recovery Plan implementation.

9 INTERESTS THAT WILL BE AFFECTED BY THE RECOVERY PLAN'S IMPLEMENTATION

- SA Department for Environment and Heritage
- South Australian coastal NRMs , including South East, Adelaide & Mount Lofty Ranges, Kangaroo Island, Northern & Yorke and Eyre Peninsula
- Local Government
- Coastal Shires, including District Council (DC) Grant, Wattle Range Council, DC Robe, Kingston DC, The Coorong DC, Alexandrina Council, City of Victor Harbor, DC Yankalilla, City of Onkaparinga, DC Kangaroo Island, DC Yorke Peninsula, DC Tumby Bay, City of Port Lincoln, DC Lower Eyre, DC Elliston, DC Streaky Bay, and DC Cednua
- Indigenous groups
- Research organisations such as universities
- Bird groups such as the Australasian Wader Study Group, South Australian Ornithologists Association and Birds Australia
- Non-government organisations such as the Threatened Species Network
- Coastal action groups such as Coastcare
- Australian Government, Department of Environment and Heritage
- Recreational fishing groups

This list of stakeholders covers the main bodies but should not be considered exhaustive. There may be other interest groups which need to be considered when particular tasks need to be undertaken.

10 NATIVE TITLE

The requirements of the *Native Title Act* 1993 only apply to land where Native Title rights and interests may exist. When implementing any recovery actions in this threatened species plan where there has been no Native Title determination, or where there has been no clear extinguishment of Native Title, there needs to be consideration of the possibility that Native Title may continue to exist. Generally the *Native Title Act* 1993 requires certain procedures to be followed before undertaking activities – known as future acts that may include certain recovery actions in this plan – which may affect Native Title rights and interests.

This threatened species plan is released and will be adopted subject to any Native Title rights and interests that may continue in relation to the land and/or waters. Nothing in the plan is intended to affect Native Title. The relevant provisions of the *Native Title Act* 1993 should be considered before undertaking any future acts that might affect Native Title. Procedures under the *Native Title Act* 1993 are additional to those required to comply with the *Aboriginal Heritage Act* 1998.

11 SOCIAL AND ECONOMIC IMPACTS

The main impact of this Recovery Plan will be the restriction of some activities such as driving along selected beaches and taking dogs onto a small number of beaches that are important Hooded Plover habitat. These limitations will be localised leaving the majority of beaches available for unrestricted recreation. Any impacts on beach users, and tourism generally, can be minimised by consulting relevant community groups and by incorporating shorebird conservation requirements into plans for nearby resorts, walking tracks, and beaches. Experience with Little Tern conservation shows that protecting breeding sites by restricting access to parts of beaches can enhance the tourist values of a particular area and can be easily accepted by most beachgoers (Schulz 1992). This has also been shown for Temporary Beach Closures implemented for Hooded Plovers (Dodge *et al.* 2005).

With a growing human population, further residential and resort development along the coast, increasing outdoor recreation, and an increasing desire by many people to seek out remote areas. Such areas include small offshore islands where there is currently small scale visitation, often no introduced predators and reasonable recruitment rates among Hooded Plovers. There is a likelihood of further disturbance of breeding shorebirds and declines in the number of Hooded Plovers in South Australia if the use of some important beaches is not well managed. The main impact of the implementation of this Recovery Plan will be the restriction of some activities such as taking dogs onto a small number of beaches that are important Hooded Plover habitat. Directing the public away from some remote beaches may also be necessary, particularly if these same beaches are also used by threatened Little Terns or Fairy Terns. However, these limitations will be localised leaving the majority of beaches available for unrestricted recreation. Some restrictions will only need to be in place during the breeding season. Further, any social and economic impacts on beach users, and tourism generally, can be minimised by consulting relevant community groups and by incorporating shorebird conservation requirements into plans for nearby resorts, walking tracks, and beaches. Another way of minimising social and economic impacts is to use measures that ensure the beach is shared fairly between humans and Hooded Plovers. For example, Temporary Beach Closure signs were effective at Mornington Peninsula National Park, and allowed humans to use the beach when the Hooded Plovers were not attempting to breed (Dowling and Weston 1999, Dodge *et al.* 2005).

The economic aspects of coastal areas are important because nearby beaches provide a livelihood and an economic return to tourism operators. Given, for example, that only 10% of Kangaroo Island's 590 km of beaches is occupied by one-third of the Hooded Plovers in South Australia (Dennis and Masters *in press*), it should be possible to manage most Hooded Plover habitat there to minimise disturbance during the breeding season without making any inroads into the economic viability of coastal businesses. Where such restrictions have been applied at very busy tourist destinations such as Phillip Island in Victoria, let alone remote beaches, there has been no reported negative impact on tourism. Indeed, tourism at Phillip Island, with its focus on natural areas and wildlife, is booming. At Mornington Peninsula National Park, many visitors to Victoria's busiest park were able to assist and participate in the effort to protect the Hooded Plover, even if only by cooperating with staff and obeying regulations. Many reported that their experiences with Hooded Plovers had enriched their visit (Dowling and Weston 1999). Experience with Little Tern conservation shows that protecting breeding sites by restricting access to parts of beaches can enhance the tourist values of a particular area and can be easily accepted by most beachgoers. Sensitive use of public viewing facilities can also benefit beach users (Schulz 1992).

Some of the costs of limiting access to some beaches may include: research and marketing needs to establish modified enterprises, and the costs of operating new recreation and tourism ventures. Commercial horse riding tours have been prohibited from using a beach at Cape Otway, Victoria, because of concern regarding the crushing of Hooded Plover nests. The operators admitted that it was impossible for them to remain below the high tide mark during the tours.

Restrictions on driving along a few beaches and taking dogs to these areas will limit the aspirations of a few people who have undertaken these activities in the past and who wish to continue to do so. Most of these concerns can be overcome by consulting relevant community groups, distributing information material, erecting signs, organising and training volunteer wardens, and incorporating shorebird conservation requirements into plans for nearby resorts, walking tracks, and beaches. All these things were conducted at Mornington Peninsula National Park but enhanced enforcement also played a big role. Even so, compliance with many laws such as keeping dogs on leads is still low (Dowling and Weston 1999, Weston 2000a).

The community, and particularly the members of the Australasian Wader Study Group of Birds Australia and its State affiliates, together with and members of other bird clubs have undertaken much of the survey work to conserve the Hooded Plover over the past two decades. This activity has provided these groups with a shared challenge, and an enjoyable means of fulfilling their mission. Wildlife agency personal have assisted in these counts and forged links between the agencies and community groups.

Experience has shown that some of the benefits of restricting dogs from a few beaches with breeding Little Terns can be to enhance the tourist values of these sites (Schulz 1992). Beaches that are promoted for their wildlife values provide opportunities for new tourism enterprises, personal satisfaction and biodiversity conservation.

12 ACKNOWLEDGMENTS

Many volunteers have undertaken surveys and studies of Hooded Plovers over the past two decades, and their efforts have made a major contribution to this Recovery Plan and other conservation work. Birds Australia, the Australasian Wader Study Group and State Wader Study Groups have co-ordinated the work of volunteers with assistance from State wildlife agencies. Jason van Weenen from DEH National Parks and Wildlife provided assistance in the preparation of the Recovery Plan and Peter Copley, Kate Fitzherbert, Sharon Gillam, Emma Ginman, Jason van Weenen, Jane Cooper, Terry Dennis and Wendy Stubbs provided editorial comments.

13 REFERENCES

Antos, M, Weston MA and Priest, B. in press. Factors influencing awareness of community-based shorebird conservation projects in Australia. Applied Environmental Education and Communication.

Baird, B and Dann, P. 2003. The breeding biology of Hooded Plovers *Thinornis rubricollis*, on Phillip Island. *Emu* 103: 323-328.

Birds Australia 2006. *Volunteer* 22: 2. Honours projects on the effectiveness of different management techniques for the conservation of Hooded Plovers and coexistence with beach users.

Blakers, M, Davies, SJJF and Reilly, PN. 1984. *The Atlas of Australian Birds*. Melbourne University Press, Melbourne.

Bransbury, J. 1985. Waders of littoral habitats in south-eastern South Australia. *South Australian Ornithologist* 29:180-187.

Bransbury, J. 1988. The status and distribution of the Hooded Plover in South Australia. Unpublished report. SA Department of Environment and Planning, Adelaide.

Bransbury, J. 1991. Biology and Behaviour of Breeding Hooded Plovers. Final Rep. Dept. Env. and Planning, SA.

Buick, AM and Paton, DC. 1989. Impact of off-road vehicles on the nesting of Hooded Plovers *Charadrius rubricollis* in the Coorong region of South Australia. *Emu* 89: 159-172.

Cameron, D and Weston, MA. 1999. The Hooded Plover: first confirmed record for Queensland, the longest movement yet recorded, and discussion of the range contraction in eastern Australia. *Australian Bird Watcher* 18: 8-18.

Christian, PD, Christidis, L and Schodde, R. 1992. Biochemical systematics of the Australian Dotterels and Plovers (Charadriiformes: Charadriidae). *Australian Journal of Zoology* 40: 225-33.

Christidis, L and Boles, WE. 1994. The taxonomy and species of birds of Australia and its territories. *RAOU Monograph 2.*

Coman, BJ, Robinson, J and Beaumont, C. 1991. Home range, dispersal and density of Red Foxes *Vulpes vulpes* in central Victoria. *Wildlife. Research* 18: 215-223.

Coxon, C. 1997. Victoria's 4WD beach closures adding to our problems. *Southern Regional Ripples* 4.

Dann, P and Baird, B. 1997. An experiment: a study of egg loss in Hooded Plovers on Phillip Island. *Stilt* 31: 54.

Dennis, TE and Masters, P. (2006). Long term trends in Hooded Plover *Thinornis rubricollis* population on Kangaroo Island, South Australia. *South Australian Ornithologist* **34**: 258-266.

Dodge, F, Weston MA, and Bunce A. 2005. Factors which mediate compliance to Temporary Beach Closures: Refining a technique to manage human disturbance to shorebirds. Wetlands International Global Series 18: 32-35.

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

Drent, RH. 1970. Functional aspects of incubation in the Herring Gull *Larus argentatus*. *Behaviour Supplement* 17: 1-132.

Drent, RH. Incubation. *In.* Farner, DS, King, JR and Parkes, KC. (*Eds*). *Avian Biology* 5: 333-420. Academic Press, New York.

DSE 2003. *Advisory List of Threatened Vertebrate Fauna in Victoria.* Department of Sustainability and Environment, Melbourne.

Garnett, ST. 1992. Threatened and Extinct Birds of Australia. RAOU Report No. 82. RAOU, Melbourne and ANPWS, Canberra.

Garnett, ST and Crowley, GM. 2000. *The Action Plan for Australian Birds*. Environment Australia, Canberra.

Hanisch, D. 1998. Effects of human disturbance on the reproductive performance of the Hooded Plover. BSc (Hons) thesis, University of Tasmania.

Hewish, M. 1989. Hooded Plovers, Pied Oystercatchers and a windy weekend at Discovery Bay, Victoria. *Stilt* 15: 24-6.

Hindwood, KA and Hoskin, E.S. 1954. The waders of Sydney. *Emu* 54: 218-255.

Hockley, C. 2000. Sanctuary for a bird at risk. *Advertiser.* December: 39.

Holdsworth, , MC and Park, P. 1993. 1992 survey of the Hooded Plover in Tasmania. *Stilt* 22: 37-40.

Lafferty, KD. 2001. Birds at a Southern California beach: seasonality, habitat use and disturbance by human activity. *Biodiversity and Conservation* 10: 1949-1962.

Lane, BA. 1981. The Hooded Plover Survey, October 1980. *Victorian Wader Study Group Bulletin* 3: 6-8.

Lane, BA. 1987. *Shorebirds in Australia.* Thomas Nelson, Melbourne.

Lane, BA. 1990. Hooded Plover survey. RAOU Vicgroup Newsletter Number 18.

McGarvie, AM and Templeton, MT. 1974. Additions to the birds of King Island, Bass Strait. *Emu* 74: 91-96.

Marchant, S and Higgins, PJ. 1993. *Handbook of Australian, New Zealand and Antarctic Birds*. *Volume II, Raptors to Lapwings*. Oxford University Press, Melbourne.

Marks, CA and Short, RV. 1996. Out-foxing the Fox. Nature Australia (Winter): 39-45.

Mathews, GM. 1913-1914. The Birds of Australia. Witherby, London.

McAllan IAW 2001. Comments on northern reports of the Hooded Plover. Australian Bird Watcher 19: 121-126.

Morris, AK. 1989. Hooded Plover survey – New South Wales. *Stilt* 14: 37.

Morris, AK, McGill, AR and Holmes, G. 1981. *Handlist of the Birds of New South Wales*, NSW Field Ornithologists Club, Sydney.

Murlis, M. 1989. Hooded Plover and Pied Oystercatcher – Victoria 1988. *Stilt* 14: 33-36.

Natt, V and Weston, MA. 1995. The results of the 1994 Hooded Plover *Thinornis rubricollis* survey for South Australia. *Stilt* 27: 36-8.

Newman, OMG. 1986. Hooded Plovers breeding at Motimer Bay. *An Occasional Stint* 4: 18-20.

Newman, OMG and Patterson, RM. 1984. A population survey of the Hooded Plover in Tasmania. *Occasional Stint* 3: 1-6.

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

Reed, J. 1975. Some birds at Sorrento in the 1930's. *Australian Bird Watcher* 6: 122-7.

Retallick, RWR, and Bolitho, EE. 1993. Disturbance of Hooded Plovers by domestic dogs. *Stilt* 23: 23.

Schulz, M. 1984. The feeding behaviour of the Hooded Plover *Charadrius rubricollis* (Gmelin) in an ocean-shore environment. BSc Hons thesis, Monash University, Melbourne.

Schulz, M. 1986. The Hooded Plover (*Charadrius rubricollis*) as a reef-forager. Stilt 9: 50-55.

Schulz, M. 1987. Flocking behaviour in the Hooded Plover *Charadrius rubricollis*. Corella 11: 28-9.

Schulz, M. 1988. The breeding of Pied Oystercatchers and Hooded Plover on wide ocean beaches - a nesting association? *Stilt* 12: 58-9.

Schulz, M. 1990. Notes on the waders of Flinders and King Islands, Bass Strait. *Stilt* 17: 40-44.

Schulz, M. 1992. Hooded Plover *Charadrius rubricollis*. Flora and Fauna Guarantee Action Statement Number 9. Department of Conservation and Environment, Melbourne.

Schulz, M and Bamford, M. 1987. The Hooded Plover an RAOU conservation Statement. RAOU Report Number 35.

Schulz, M, Grant, A and Lumsden, L. 1984. Some aspects of the feeding behaviour and diet in the Hooded Plover, *Charadrius rubricollis* (Charadriidae), during the non-breeding season. *Stilt* 5: 2-8.

Schulz, M and Menkhorst, KA. 1984. A survey of the waders of south-west Tasmania. *Stilt* 5: 21-24.

Smith, FTH. 1964. Wader observations in southern Victoria, 1962-1963. *Australian Bird Watcher* 2:70-84.

South Australian Government 1993. National Parks regulations 1990. *South Australian Government Gazette*, March 1993: 889-890.

Stephens, E. 2004. Life's a beach: Habitat preference and disturbance impacts on Hooded Plover, a globally threatened shorebird. BSocSc. (Hons), University of Adelaide.

Stewart, ID. 1989. Hooded Plover survey – South Australian/Victorian border to Murray mouth. Stilt 14: 32-3.

Stewart, ID. 1993. 1992 Hooded Plover survey, South Australia. *Stilt* 22: 44.

Thomas, DG. 1968. Waders of Hobart. *Emu* 68: 95-125.

Tomkovich, P and Weston , MA (In press). Breeding Ecology. In: Geering, A (Ed). Shorebirds of Australia: Their Ecology and Conservation. Queensland Wader Study Group, Brisbane.

Weston, MA. 1993. Twelve years of counting the Hooded Plover in Victoria, Australia. *Stilt* 23: 15-19.

Weston, MA. 1995. Results of the 1994 Hooded Plover *Thinornis rubricollis* survey of Victorian beaches. *Stilt* 27: 39-43.

Weston, MA. 1998a. Some undescribed aggressive behaviours, displays and calls of the Hooded Plover in Western Australia. *Western Australian Naturalist* 22: 105-114.

Weston, MA. 1998b. An observation of aggression between a Hooded Plover and a Black-fronted Dotterel. Aust. Bird Watcher 17: 301-302.

Weston, MA. 1998c. Nankeen Kestrel takes Hooded Plover chick. *Australian Bird Watcher* 17: 266-7.

Weston, MA. 2000. The effect of human disturbance on the breeding biology of the Hooded Plover. PhD thesis, University of Melbourne.

Weston, MA 2003. Managing the Hooded Plover in Victoria. *Parks Victoria Technical Series* No. 4.

Weston, MA, Burke AJ, Ford VL, Stewart, ID and Dowling, B. 1998. Four-egg clutches in the Hooded Plover: description, occurrence and female investment, *Australian Bird Watcher* 17: 383-389.

Weston, MA and Elgar, MA, 2005a. Disturbance to brood-rearing Hooded Plover *Thinornis rubricollis*: responses and consequences. *Bird Conservation International* 15: 193-209.

Weston, MA and Elgar MA. 2005b. Parental care in Hooded Plovers (*Thinornis rubricollis*). Emu 105: 282-292.

Weston, MA and Elgar, MA, (In press). Responses of incubating Hooded Plover *Thinornis rubricollis* to disturbance. Journal of Coastal Research

Weston , MA and Morrow, F. 2000. Managing the Hooded Plover in western Victoria. Unpublished report to Parks Victoria, Melbourne.

Weston, MA and Paton, S. 2001. The 2000 Hooded Plover count for Victoria: report to participants and newsletter 1: 1-2.

Weston, MA and Peter, PM 2004. The occurrence of Hooded Plovers in Port Phillip Bay. Victorian Naturalist 121: 274-283.

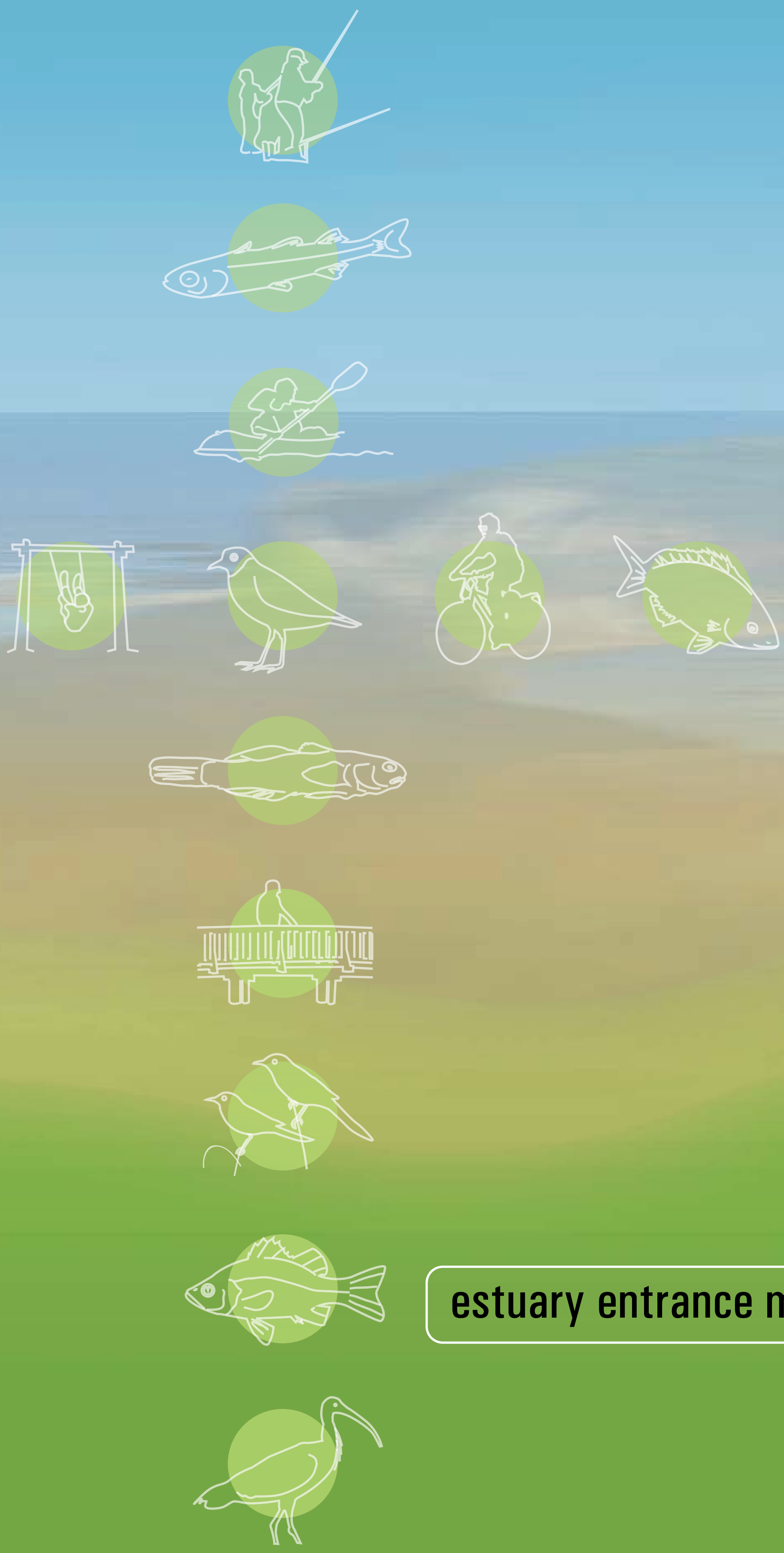
Weston MA, Kraaijeveld-Smit FJL, McIntosh R, Sofronidis G, Elgar MA. 2004. A male-biased sex-ratio in non-breeding Hooded Plovers on a salt-lake in Western Australia. Pacific Conservation Biology 9: 273-277.

Whitelaw A, Whitelaw J, Weston MA. 2005. Delayed dispersion of a juvenile Hooded Plover from its natal territory. The Stilt 48: 10-12.

Woehler, EJ and Park, P. 1997. Interim report on the status of Hooded Plovers in Tasmania. Unpublished report to Tasmanian Parks and Wildlife Service, Hobart.

Whiter, J. 1991. Systematic List: Birds. *Nature in Eurobodalla* 6: 3-39.

Appendix 15 – Estuary Entrance Management Support System



EEMSS

estuary entrance management support system


**The Estuary Entrance Management Support
estuary managers when making the decisio
EEMSS will ensure a consistent process is
and openings ar**

Estuaries and associated wetlands...

are one of the most valuable ecosystems. They provide spawning and nursery areas for fish and breeding and foraging areas for birds.

Estuaries also have an important function as natural sediment and nutrient filters thereby providing cleaner water to the estuary and inshore zone. Apart from their ecological value, estuaries are an important tourist destination and provide many recreational opportunities such as fishing, bird watching and boating.

Many estuaries in Victoria intermittently close following the formation of a sand bar at the mouth of the estuary. The resultant increase in water level within the estuary has an environmental benefit when adjoining wetlands and fringing vegetation are flooded. However, there are also economic costs associated with flooding of infrastructure and agricultural land. While estuary closure is a natural event catchment activities such as clearing and water extraction can alter the flow to estuaries and potentially affect the timing or extent of estuary mouth closure.

Historically estuaries in Victoria have been opened to protect infrastructure and agricultural land. There has been limited consideration of environmental values which could potentially be compromised by the decision to either open or not open the estuary.

DEVELOPMENT OF EEMSS

Community workshops were used to identify the uses and functions of estuaries and surrounding land that should be protected when making the decision whether or not to open an estuary. The range of assets listed reflected the value of estuaries as important habitats, cultural sites, areas for recreation and sites for economic development, particularly for tourism and agriculture.

SOCIO-ECONOMIC

Roads & bridges	Agricultural land
Fishing	Jetties
Walking tracks	Boat ramps
Recreational land	Camping
Swimming	Built Infrastructure
Stormwater	Septics
Human health	Watercraft

ENVIRONMENTAL

Fish
Plant communities
Birds

CULTURAL

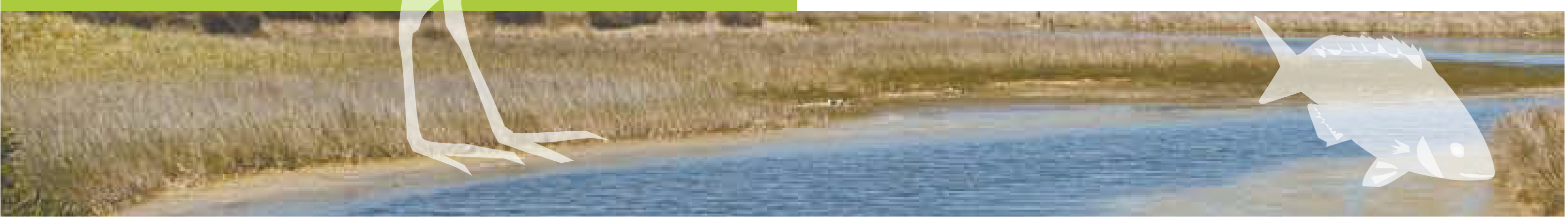
Cultural heritage
Indigenous culture

The workshops also identified some concerns with current estuary entrance management. In summary the community wanted:

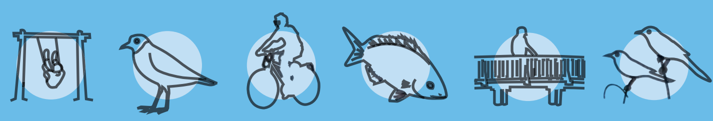
- Consistency
- Education to promote estuarine values
- 'Indicators' other than water height to be considered
- Other ways to minimise the impacts of flooding
- Stronger, ongoing communication between researchers, community and managers
- The impact of artificially opening the mouth of an estuary to be monitored

Agencies responsible for estuary management required that the decision support system be:

- A transparent system
- Easy to use
- Not reliant on extensive data collection
- Adaptive i.e.able to respond to monitoring
- Applicable to all intermittently - closed estuaries in Victoria but able to incorporate the uniqueness of each estuary



t System (EEMSS) is a database that will guide
n whether or not to artificially open an estuary.
followed each time so all assets are considered
e safe and effective.



COMPONENTS OF EEMSS

EEMSS comprises three basic components:

1. An impact assessment **2. A checklist** **3. Data storage**

An **impact assessment**, based on an assets-threats model ensures a consistent process is used when making the decision whether or not to open an estuary. It also ensures that the decision considers the environmental, cultural and socioeconomic values of each estuary.

Experts in the relevant disciplines were engaged to develop the rules for scoring both the assets and the threat to those assets posed by opening or not opening an estuary. **Threat modifiers** were also identified for some assets. These included, how long the water has been at a given level, whether the area is affected by drought, and dissolved oxygen levels of the water. Rules have been developed to describe how these factors alter the level of threat associated with opening or not opening an estuary.

For each estuary, the community and other experts will be asked to use the rules developed to assign scores to both the assets, and the threat to those assets of opening or not opening an estuary. Scores will vary with water level and time of the year.

ASSET SCORE
Level of importance of the asset to the use or function of the estuary

THREAT SCORE
Threat level associated with opening or not opening an estuary

THREAT MODIFIERS
Factors that could change the assigned threat score

IMPACT SCORE

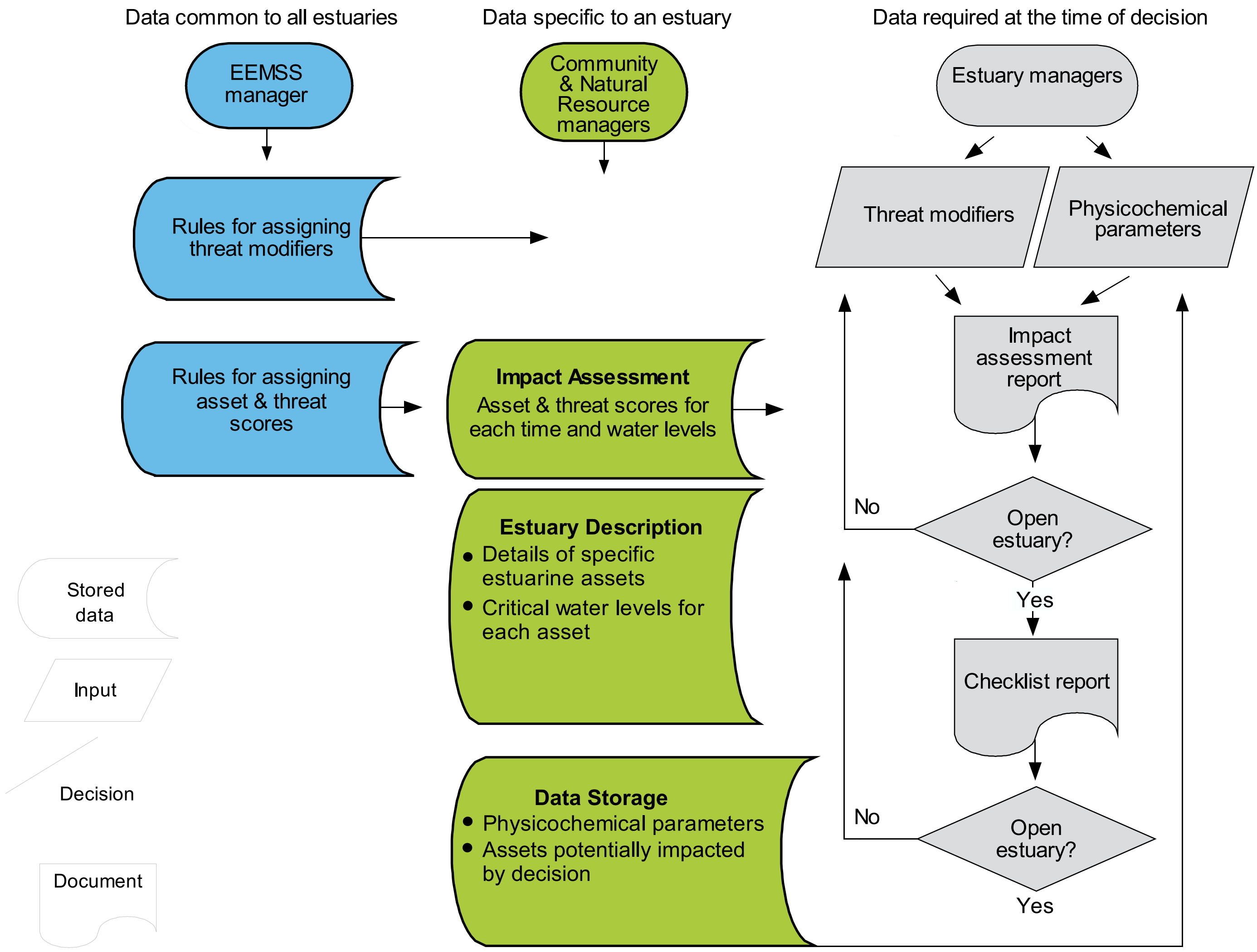
At the time of making a decision about opening an estuary, the manager will input information about the threat modifiers. This may change some of the threat scores previously assigned. EEMSS will combine the asset and threat scores to produce an impact score. The **impact assessment report** will list the impact of opening and not opening the estuary on the assets identified for that estuary. If after consideration of the impact assessment report the manager decides to open an estuary they are required to complete a **checklist report**. This ensures a consistent protocol is followed when the mouth is opened so openings are safe and effective. Examples of the information required includes placement of warning signs, sea conditions and tides.

For an estuary to be artificially opened, both the impact assessment report and the checklist report must support that decision.

A data storage section will store information about physicochemical parameters such as, estuarine water levels, mouth status, oxygen levels, salinity and temperature. Some of this information is currently collected by community members and agencies. Managers wil also be able to store information about assets that were identified in the impact assessment report as potentially impacted by their decision.

The data collected will help inform future management decision and allow agencies to better target monitoring programs.

LINKING THE COMPONENTS OF EEMSS



Further Information

For further information about the EEMSS project contact your local catchment management authority.

Acknowledgements

Development of EEMSS was funded by the Natural Heritage Trust. A steering committee with representatives of Deakin University, Glenelg Hopkins Catchment Management Authority, Corangamite Catchment Management Authority, The Environment Protection Authority, Parks Victoria, the Western Coastal Board, Department of Sustainability and Environment and Department of Primary Industries provided ongoing guidance.

Appendix 16 – Glossary Of Terms

AEOLIANITE

A rock formed from calcareous dune sands, a dune calcarenite

ALIEN

Species from outside the region

BASE GIS LAYER

The original GIS (Geographic Information System) layers stored within

databases which are used as the basis for analysis. The Base GIS layers are represented as vector datasets within databases, with these vector datasets representing a wide range of real world features(with a geographic location).

These GIS features are of three types:

Points (eg. the location of Biological Survey Sites),

Lines (eg. the location of an unsealed roads or tracks) &

Polygon (eg. the location of Mangrove Habitat or the location of Conservation Parks).

Each base GIS layer may be an accumulation of many occurrences of the same type and theme – for example the 'Biological Survey Flora Points' will include thousands of individual survey sites each containing a number of plant types at each site.

BEACH

A sand or pebble slope, gently or moderately inclined, built up or eroded by waves, forming the shore of a lake or sea (McDonald et al, 1990), over which the swash and backwash operate (Short & Fotheringham, 1986)

BEACH RIDGE

A very long, nearly straight low ridge, built up by waves and usually modified by wind. A beach ridge is often a relict feature remote from the beach (McDonald et al, 1990), formed of shingle or shell debris, (Short & Fotheringham, 1986*)* see foredune ridge

BEACH RIDGE PLAIN

level to gently undulating landform pattern of extremely low relief on which stream channels are absent or very rare: it consists of relict parallel beach ridges (McDonald et al, 1990), beach ridges are linear, symmetric or asymmetric, convex ridges formed of shingle or shell debris.*,* storm or swash wave derived (Short & Fotheringham, 1986*)*

BLOWOUT

erosional trough generally initiated through vegetation loss within a coastal dune by natural (e.g. wave erosion, fire) or other causes (e.g. impact of vehicle or foot traffic).

CALCAREOUS SANDS

Beach or dune sands that contain high carbonate content; usually derived from the fragmented shells of marine organisms.

CELL

A term used in this report to indicate a small coastal area, defined on landform grounds, for the purpose of description within the coastal boundary. [The Southern Fleurieu coastal boundary is divided into 27 cells].

CHENIER

Long low ridges composed of wave washed sand-shell material. Commonly occur within saltmarsh suprastidal areas, marking the limit of a storm surge induced flood episode.

CLIFF

Steep, vertical or overhanging slope, usually over 5m high, at the coast. Cliffs are eroded by a variety of processes, and over time the steepness is maintained by wave removal of debris from the cliff base. If marine processes are excluded from the base, debris will slowly accumulate and the cliff slope reduced.

CONSOLIDATED DUNEFIELD

level or rolling landform pattern of very low or extremely low relief without stream channels, built up or locally excavated, eroded or aggraded by wind and consolidated by stabilising effects of vegetation (modified from McDonald et al, 1990), *not lithified*

DATA THEME/ DATA LAYER

The expression used to define one type of GIS data. This data will always be of the same geographic type eg. points. In some occasions numerous data sources concerning the same type of information can be combined to form one Data Theme or Layer.

DUNE/CONSOLIDATED DUNE

moderately inclined to very steep ridge or hillock built up by wind. This element may comprise dunecrest and duneslope. May also be consolidated due to stabilising effects of vegetation (modified McDonald et al, 1990), includes hind dunes.

DUNEFIELD

level to rolling landform pattern of very low or extremely low relief without stream channels, built up or locally excavated, eroded or aggraded by wind (McDonald et al, 1990), *not lithified*

DUNEFIELD LITHIFIED; DUNE CALCARENITE/DUNEROCK

whole or portion of a sand dune that has been lithified to some degree, lithification is usually associated with partial solution and precipitation of calcium carbonate which cements the sand grains (Short & Fotheringham, 1986)

ENDEMIC/

native to or confined to a certain region

ENVIRONMENTAL WEED

Term that refers to those naturalised plant species that have invaded areas of native vegetation. The species is presumed to impact negatively on native species diversity or ecosystem function. Environmental weeds are usually non-native species, although native plants species that are invasive beyond their indigenous range are also included

ESCARPMENT

steep to precipitous landform pattern forming a linearly extensive, straight or sinuous inclined surface, which separates terrains at different altitudes, that above the escarpment commonly being a plateau. Relief within the landform pattern may be high (hilly) or low (planar). The upper margin is often marked by an included cliff or scarp (McDonald et al, 1990)

EXOTIC

Species from outside the region

FOREDUNE

very long, nearly straight, moderately inclined to very steep ridge built up by the wind from material from an adjacent beach (McDonald et al, 1990), The foredunes are formed by vegetation trapping aeolian sand on the backshore zone, above the tide line. Foredunes range from quite small (approximately 2m) to very large (over 30m), very stable to very unstable (ie vegetation cover may display great variation) and may be morphologically diverse. Generally they comprise a frontal or stoss slope, crest and lee or landward slope (Short & Fotheringham, 1986)

FOREDUNE RIDGE

foredune ridges are dune ridges which were initiated as foredunes and then later were removed from the influence of beach processes by seaward secretion, and the formation of a new foredune, (Short & Fotheringham, 1986), they are aeolian in origin in contrast to beach ridges which are wave derived

GEOREFERENCED

The state in which a raster dataset is positioned in space using map coordinates. Each feature within the GIS layer will have a corresponding real-world feature on the ground at the same geographic location. Georeferencing data allows it to be viewed, queried, and analysed with other geographic data.

GIS (Geographic Information System)

An organised collection of computer hardware, software, geographic data, and personnel designed to efficiently capture, store, update, manipulate, analyse, and display all forms of geographically referenced information. A GIS may be used for a project (also called project GIS, or single-user GIS), by a department of an organisation to support a key function of that department (called departmental GIS), or by an organisation to support daily activities and strategic decision making (called enterprise GIS).

GRID

A geographic representation of the world as an array of equally sized square cells arranged in rows and columns. Each grid cell is referenced by its geographic x,y location.

GRID CELL**:** See RASTER CELL.

GULLY

open depression with short, precipitous walls and moderately inclined to very gently inclined floor or small stream channel, eroded by channelled stream flow and consequent collapse and water-aided mass movement (McDonald et al, 1990)

HIND DUNE

any dune or dune system lying landwards of the foredune (Short & Fotheringham, 1986)

INCIPIENT FOREDUNE

newly forming foredunes occupying a primary beach location behind the spring tide swash limit, and vegetated by pioneer colonisers, semi-erect and erect grasses and prostrate herbaceous plants. The incipient foredunes are formed by vegetation trapping aeolian sand on the backshore zone, above the tide line. Once secondary (woody) plant species colonise the incipient foredune, it may be simply termed foredune. (Short & Fotheringham, 1986)

INTERDUNE CORRIDOR

generally wide, linear, level floored open depression between parallel dunes (modified McDonald et al, 1990)

INTER-TIDAL FLAT

an area of low relief that lies within the range of the astronomical tides. If the area lies on the seaward side of the saltmarsh it may also be influenced by wave action.

INTER TIDAL SALTMARSH

the area that is regularly (daily) flooded by the astronomical tide

INTRODUCED

Species from outside the region

INVASIVE PLANTS

Naturalised species that are spreading

LEVEE BANK

an artificial bank built to limit the area of flooding

LIMESTONE PLAIN

large, very gently inclined or level element of hard almost horizontally bedded limestone (a class of rock which contains at least 80% of the carbonates of calcium or magnesium

LITHIFIED

the state of having been cemented or compacted so as to form solid rock

LONGITUDINAL DUNEFIELD

dunefield characterised by long narrow sand dunes and wide flat swales. The dunes are orientated parallel with the direction of the prevailing wind, and in cross section one slope is typically steeper than the other (McDonald et al, 1990)

MANGROVE

forest plant community that occupies the narrow intertidal zone between the land and the sea. South Australia has only one species of mangrove (*Avicenna marina ssp resinifera,* the Grey Mangrove).

NATURALISED SPECIES

Species from outside the region in question that can maintain populations in the wild without cultivation.

PARABOLIC DUNEFIELD

dunefield characterised by sand dunes with a long scoop-shaped form, convex in the downwind direction so that its trailing arms point upwind: (McDonald et al, 1990)

PLAIN

level to undulating or, rarely, rolling landform pattern of extremely low relief (less than 9m) (McDonald et al, 1990)

PLATEAU

level to rolling landform pattern of plains, rises or low hills standing above a cliff, scarp or escarpment that extends around a large part of its perimeter. A bounding scarp or cliff landfrom element may be included or excluded: a bounding escarpment would be an adjacent landform pattern (McDonald et al, 1990)

RASTER

Represents any data source that uses a grid structure to store geographic information.

RASTER CELL

A discretely uniform unit (square or rectangle) that represents a portion of the earth such as a square meter or square mile. Each pixel has a value that corresponds to the feature or characteristic at that site such as a soil type, census tract, or vegetation class.

RASTERISATION

The process by which base vector GIS layers are modified and stored as a raster layer.

RESISTANCE

The ability of an ecosystem to withstand disturbance without undergoing a phase shift or losing neither structure nor function (Odum, 1989). For example, a swamp paperbark's ability to withstand groundwater salinity change and mortality.

RESILIENCE

The ability of a system to absorb or recover from disturbance and change, while maintaining its functions and services (Adapted from Carpenter et al, 2001). For example a vegetation association 's ability to recover from an extended drought event.

SALTMARSH

saltwater wetland occupied mainly by herbs and dwarf shrubs, characteristically able to tolerate extremes of environmental conditions, notably waterlogging and salinity

SAMPHIRE

A community of halophytic plants either herbaceous or shrubby that occur to the landward side of the mangroves (and sometimes within)

SEAGRASS

marine plant that colinises either the intertidal mud or sandflat to the seaward sise of the mangroves or saltmarsh. Seagrass also extends to the subtidal.

SCARP

very wide steep to precipitous maximal slope eroded by gravity, water-aided mass movement or sheet flow (McDonald et al, 1990)

SHORE PLATFORM or ROCKY REEF

Exposed rocky substrate within the intertidal zone.

STRANDED TIDAL

An area formerly tidal, but which have since been isolated from tidal influence by dunal development, levee bank (road) construction, or b y changes in sea level or landform uplifting

SUB-TIDAL

SUPRA-TIDAL

the drier area less frequently inundated by the tides (monthly)

SWALE

linear, level-floored open depression excavated by wind, or left relict between ridges built up by wind or waves, or built up to a lesser height than them (McDonald et al, 1990)

TURBIDITY

Cloudy water, usually caused by the suspension of fine particles in the water column. The particles may be inorganic (e.g. silt) or organic (e.g. single-celled organisms).

WEED

Species that adversely affect biodiversity, the economy or society

Geological Time

HOLOCENE

10 000 years before present to present - predominantly unlithified

PLEISTOCENE

1.6-1.8 millions of years before present - lithified

TERTIARY

from 5-65 million years before present - limestones

PRECAMBRIAN

2600 millions of years before present - metasediments, granites etc

Conservation Categories

E	Endangered: in danger disappearing from the wild state within one or two decades if present land use and other causal factors continue to operate
V	Vulnerable: rare and at risk from potential threats or long term threats which could cause the species to become endangered in the future
R	Rare: has a low overall frequency of occurrence (may be locally common with a very restricted distribution or may be scattered sparsely over a wider area). Not currently exposed to significant threats, but warrants monitoring and protective measures to prevent reduction of population size
T	Threatened: likely to be either Endangered or Vulnerable but insufficient data for a more precise assessment
K	Uncertain: likely to be either Threatened or Rare but insufficient data for a more precise assessment
Q	Not yet assessed but flagged as being of possible significance
U	Uncommon: less common species of interest but not rare enough to warrant special protective measures
N	Not of particular significance/Common

South Australian Vegetation Structural Formations

	Projective Foliage Cover of Tallest Stratum			
Life Form/ Height Class	Dense 70 - 100%	Mid-Dense 30 - 70%	Sparse 10 - 30%	Very Sparse 1 - 10%
Trees > 30m Trees 10 - 30m Trees 5 - 10m Trees < 5m	Tall closed forest Closed forest Low closed forest Very low closed forest	tall open forest open forest low open forest very low open forest	tall woodland woodland low woodland very low woodland	tall open woodland open woodland low open woodland very low open woodland
Mallee (>3m) Low Mallee (<3m)	Closed mallee Closed low mallee	mallee low mallee	open mallee open low mallee	very open mallee very open low mallee
Shrubs > 2m Shrubs 1-2m Shrubs <1m	Tall closed shrubland Closed shrubland low closed shrubland	tall shrubland shrubland low shrubland	tall open shrubland open shrubland low open shrubland	tall very open shrubland very open shrubland low very open shrubland
Mat plants Hummock grass Tussock Grasses Herbs	closed mat plants closed hummock grassland closed tussock grassland closed herbland	mat plants hummock grassland tussock grassland	open mat plants open hummock grassland open tussock grassland	very open mat plants very open hummock grassland very open tussock grassland
Sedges)	closed sedgeland	sedgeland	open sedgeland	very open sedgeland
Ferns	closed fernland	fernland	open fernland	very open fernland

(Source: Adapted from Specht, 1972 and Muir, 1977)

Appendix 17 – Maps