Managing the Hooded Plover in Victoria: A site by site assessment of threats and prioritisation of management investment on Parks Victoria managed land.

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Executive Summary

Hooded Plovers are a threatened, beach-nesting bird endemic to southern Australian ocean beach habitats. In Victoria, the species is listed as Vulnerable and Parks Victoria is responsible for managing 76.1% of the statewide Hooded Plover population. Mornington Peninsula National Park and Belfast Coastal Reserve contain the highest density of Hooded Plovers as well as key winter flocking sites, while a number of additional parks contain high numbers of breeding sites, are key flocking sites and act to maintain habitat connectivity.

In recent years there has been much research and data collection which has provided new insight into the threats which impact Hooded Plover breeding success and the success of management investments. Approximately half of the breeding population along the Victorian coast is monitored by volunteers participating in BirdLife Australia's Beach-nesting Birds program. In three of the five consecutive breeding seasons over which monitoring occurred (2006/07-2010/11), breeding success (standarised as the number of fledglings per pair) was lower on Parks Victoria managed coastline than for pairs on non-Parks Victoria managed coastline.

Some parks are accounting for a greater input into the overall productivity of the Victorian population than others. This is not however directly proportional to the size of the park and density of breeding pairs within. Bunurong Coastal Reserve and Marlo Coastal Reserve have few breeding pairs but success from at least 67 to 75% of breeding locations. The two most densely populated parks, Belfast Coastal Reserve and Mornington Peninsula National Park, have had successful fledging events from only 44% and 50% of breeding locations over five breeding seasons respectively. This indicates that approximately half of the breeding sites in these two parks are currently acting as breeding 'sinks'.

Threat profiles were produced for each park based on a subset of sites monitored over five years. Foxes were the most consistently recorded threat within nine of the 14 monitored parks. Dogs off leash most frequently occurred across all parks combined; however, this was highly variable between individual parks. Most distinctive of any park threat profile was that of Belfast Coastal reserve, where horses were present on 66.27% of visits. Vehicle use was also highest in Belfast Coastal Reserve, as well as in Narrawong Coastal Reserve. In both of these coastal reserves, the observed vehicle access is that of illegal recreational access. Remoter parks, particularly at the far extremes of the Victorian coast had higher occurrences of avian predators. Four parks were compared in terms of number of visitors and dogs on and off leash observed, revealing considerable variation that is not explained by the land reservation status of those parks.

The spatial spread of successful and unsuccessful sites within parks does not appear to be random. In the Mornington Peninsula National Park, breeding success spatial patterns appear most closely matched to the spatial distribution of frequency of occurrence of dogs off leash.

Determining management investment into parks and sites should be based on the value of these areas to the species (e.g. density, presence of winter flocking sites, connective value to maintaining dispersal across the coast) as well as the source of threats (a priority is to minimize human related impacts), the response of threats to management (e.g. does investment pay off?) and the presence of volunteer support.

There are several threats which can be managed at the landscape scale to benefit multiple pairs. These include predator control, weed control, and sympathetic policies/planning considerations, as well as education to bring about sustainable beach use by recreationists. This report provides vehicle access protocols, and horse and dog access management strategies, as well as event management protocols and education strategies.

Current fledging rates are the result of considerable (but highly localised) management investment across the Victorian coast: close to fifty percent of fledglings produced by approximately half of Victoria's population of Hooded Plovers came from highly threatened beach sites where management occurred at the breeding site level. If the population relied on the breeding success of pairs in isolated or inaccessible sites, then fecundity would only be half of what was achieved with management. This would double current calculations from a 22% to a 44% Hooded Plover population decline within 10 years. This creates strong justification for investing at the site level.

Finally, monitoring forms an essential component of any management investment. Current Hooded Plover management is shaped by monitoring results being fed back into management decisions and prioritisation processes, to ensure learning and adaptation of responses over time, which ultimately leads to successful outcomes.

Chapter 1- Species Introduction

Chapter 1 describes the Hooded Plover in detail including its appearance, taxonomy and ecology (habitat, diet, social structure, movements and breeding ecology). The conservation status of the species is briefly discussed, with evidence of population declines presented and probability of extinction explored. In March 2012, this led to the nomination of Hooded Plover (eastern) for EPBC listing as nationally Vulnerable, which is currently under consideration, with the decision to be announced 30th September 2015.

Species Description

The Hooded Plover (*Thinornis rubricollis*) is a small black, white and grey shorebird with red eye (orbital) ring and tip of beak. Adult birds measure 19-23 cm in size and weigh between 90-100 g (Marchant and Higgins 1993). There are no differences in plumage or size between the sexes, nor are there seasonal or breeding plumage variations in the species. Juvenile birds differ in appearance to the adults. These variations include head, collar and breast-patches being a pale dull grey-brown with mottling, the chin and throat being whitish with washed grey feathers and the orbital ring being pale orange rather than red.

Adult Hooded Plover (Grainne Maguire)

Adult Hooded Plover (Dean Ingwersen)

Subadult Hooded Plover approximately 8 months old (Grainne Maguire)

Juvenile Hooded Plover approximately 45 days old (Grainne Maguire)

Hooded Plover chick approximately 32 days old (Grainne Maguire)

2 day old Hooded Plover chicks (Grainne Maguire)

Similar species include the Red-capped Plover (endemic to Australia, often breeds on beaches), Double-banded Plover (a migratory species from New Zealand present in Australia in winter months) and in flight, the Ruddy Turnstone. However, the Hooded Plover is distinguished from all other small shorebirds in Australia by its white nape (collar) that is present from chick stage to adulthood.

Left: Female red-capped plover (Glenn Ehmke); Right: Double-banded plover (Glenn Ehmke)

Taxonomy

This Australian resident shorebird species occurs in two distinct populations which are considered separate subspecies; the Western population in Western Australia (*T. r. tregellasi*) and the Eastern population in South Australia, Victoria, New South Wales and Tasmania, including the Bass Strait islands (*T. r. rubricollis*).

The eastern and western populations vary significantly in their morphology and genetics (Bennett 2010), as well as distinct differences in the ecology and habitat of the two forms, with the eastern population confined exclusively to coastal environments, while the western population primarily inhabit inland salt lakes, are more mobile according to seasonal variation in hydrology, and have a less defined breeding season. There is no evidence of demographic exchange between the two populations despite hundreds of

birds having been colour-marked and extensive survey effort in both the eastern and western ranges of the species. The populations are separated by a long expanse of fundamentally unsuitable habitat (the Nullabor Plain, some 700 km) which exceeds the known gap crossing ability of the species (Weston *et al.* 2009). Long term geographic isolation of the eastern and western populations is known to drive sub-specific taxonomic variation (Schodde and Mason 1999; Black 2011; Black *et al.* 2010; Ford 1987; Christidis *et al.* 2010), leaving little doubt the two are distinct subspecies.

The Hooded Plover (eastern) is the subject of this report and so where the term 'species' appears, unless otherwise specified, this applies to the eastern subspecies.

Map of Hooded Plover distribution across Australia. Green delineates the western Hooded Plover range, Blue the current Eastern Hooded Plover range and Red the former species range.

Left: the western Hooded Plover (Marcus Singor); Right: the eastern Hooded Plover (Glenn Ehmke)

Hooded Plover ecology

Habitat

Broadly, the Hooded Plover (eastern) inhabits surf beaches and coastal salt lakes, where available. They preferentially select ocean beaches, particularly wide beaches with wide wave-wash zone backed by dunes with large amounts of beach-washed seaweed (Weston 2003), and creek mouths or inlet entrances. The species is occasionally seen on tidal bays and estuaries or on rock platforms or small beaches in lines of cliffs where the beach is backed by dune or foredune humps. In SA they have also been recorded on ephemeral hypersaline lagoons and lakes within 3km of the coast (Ewers *et al.* 2011; Dennis and Ball 2013).

The presence of seaweed which is influenced by the tide and ocean currents appears to be a key requirement. Decaying seaweed provides a substrate upon which the Hooded Plovers forage for invertebrates, as well as potentially providing a direct food source for the species (Weston 2003).

Hooded Plovers (eastern) use beach habitats for feeding, roosting, breeding and dispersing. A breeding territory will typically consist of a stretch of beach over which the birds will forage, including on intertidal rock platforms, river mouths or outlets, and on the beach at all levels but predominantly at the water's edge and along the wrack line. The territory also contains suitable nesting habitat which can include dune blowouts, foredune and dune, dune faces, the edge of estuaries and anywhere on the beach above the high tide mark. Hooded Plovers appear to select against heavily vegetated areas of the dune for nesting, and to prefer nesting close to dead objects (e.g. stick, seaweed). They also prefer to place dune nests nearer the foredune, that is more towards the seaward side than landward side of the dunes (Mead 2012; Cribbin 2012).

Recent habitat modelling (Ehmke *et al.* in prep.) investigating the importance of key ecological and landscape variables from the sub- and super-tidal zones of coasts, revealed that the proportion of reef, rock and foredune habitat, and presence of dune habitat were key determinants of Hooded Plover presence. These obligate beach birds therefore appear to select habitats which are influenced by processes above the beach, and below the high tide mark.

This habitat modelling work has revealed that we could grossly overestimate habitat availability if we were to consider all ocean beach sandy shore as habitat. Some earlier distributional models of the species over-estimate occurrence, largely due to the inaccuracy of the data set on which they were based (e.g. State government databases such as Atlas of Victorian Wildlife contain unmoderated Hooded Plover records) and which previously viewed all high-energy ocean beach as potential habitat. We now have data to support that the species has a more limited habitat range.

Diet and foraging behaviour

Hooded Plovers forage in sand at all levels of wave-wash during low and mid-tide or among seaweed at high tide when inhabiting ocean beaches (Marchant and Higgins 1993). On rocks they forage in wave-wash or spray zones, rarely utilising shallow rock pools. The species appears to avoid elevated rocky areas, boulder fields above lower littoral zone and lower littoral zones covered in algae.

In coastal lagoons and salt lakes in South Australia the species forages mostly on dry substrates and occasionally damp substrates during the summer. As the seasons change, the species will forage more in damp and shallowly inundated areas.

Feeding is both diurnal and nocturnal, and typically a run-stop-peck manner. This is typical of *Charadrius* plovers. Gleaning and probing behaviours have also been recorded (Marchant and Higgins 1993).

The diet of the Hooded Plover comprises of a range of invertebrates (polychaetes, crustaceans, molluscs, insects) as well as some plant material including seeds and turions (over wintering bud of aquatic plants) (Marchant and Higgins 1993).

Weston (2007) studied the foraging behaviour and diet of Hooded Plovers in the non-breeding season in 3 different habitats; a salt lake (Lake Gore in WA), a brackish near-coastal lake (Lake Victoria) and on Victorian beaches. He found that birds foraging on beaches probed more, had more successes and foraged slower than birds on salt lakes in WA. Foraging at the brackish lake was slowest of all. The diet of coastal birds was dominated by crustaceans and insects whereas birds on salt lakes primarily, and almost exclusively, consumed *Coxiella* spp., an endemic gastropod (snail). This study described two additional prey items previously not detected in the species diet, including moths and ants.

Movements and social distribution

Weston *et al.* (2009) examined the movements of colour-banded Hooded Plovers in Victoria by analysing sightings of colour-banded birds (194 birds tracked for up to 9 years). Most movements were relatively short (~5km), with 61.4% <1 km and 95.3% <20 km. The maximum movement recorded was 330.8 km.

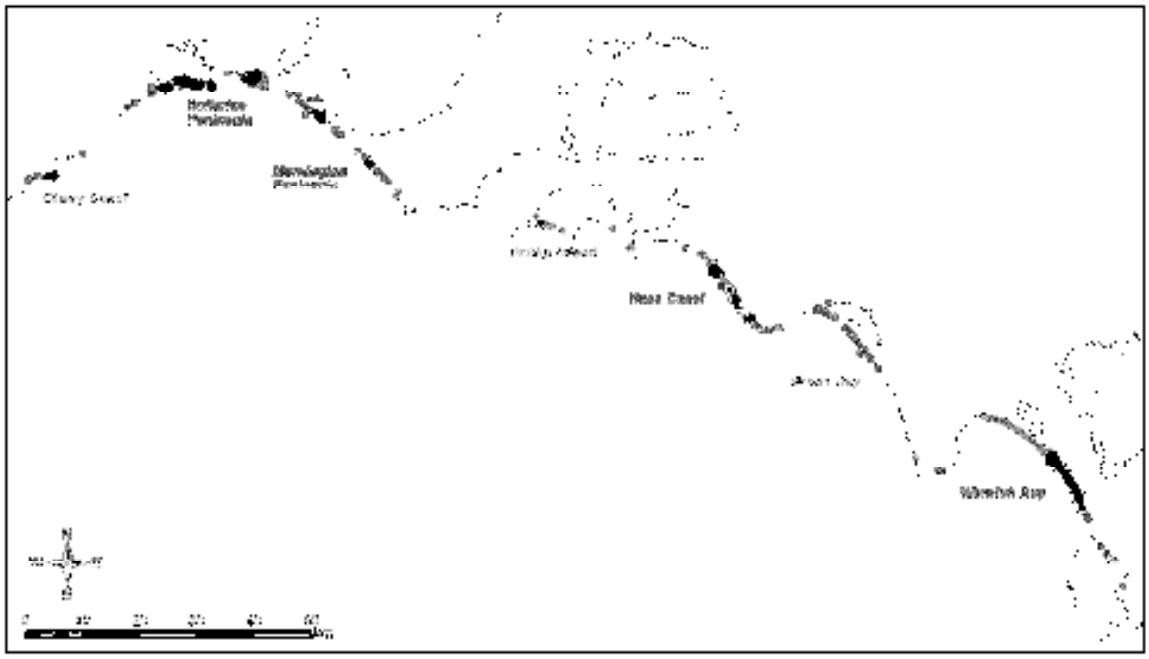
During the breeding season (August to March), Hooded Plovers pair off and occupy breeding territories of approximately 1km of beach (36.7 ± 5.7 ha) which they vigorously defend (Weston *et al.* 2009). Breeding territories overlap from year to year in all cases. The birds spend little time off their territories, lending strength to the contention that the territories defined here are the core spatial unit of most ecological relevance for breeding Hooded Plovers. The high fidelity and constancy of territories confirms they warrant ongoing management investment.

Non-breeding birds without territories (floaters) typically spend time in smaller flocks or moving through occupied sites, where they will be driven off by territorial pairs, particularly when they are nesting (Weston *et al.* 2009).

In the non-breeding months, Hooded Plovers can remain on territory or disperse to flocking sites which are typically on beaches, estuaries or coastal/near coastal salt lakes. The furthest inland Hooded Plovers have been observed in Victoria was 1500 m inland at Lake Victoria, an inland brackish lake on the Bellarine Peninsula. Weston *et al.* (2009) revealed that these flocking sites are not chosen at random, but rather they are selective of particular wintering locations (see Figure 1). Comprehensive surveying effort has shown that there are areas of coastline apparently unoccupied during the non-breeding

season. Substantial gaps were apparent along the coast in places such as the western half of Waratah Bay (west of Shallow Inlet) and parts of the Mornington Peninsula. All of these areas supported breeding Hooded Plovers, and thus are broadly suitable habitat. This indicates that there may be unique habitat features of these flocking sites that support non-breeding flocks.

Figure 1. Major flocking sites (black polygons) as defined by Quartic Fixed Density Kernel Analysis in relation to all colour-banded Hooded Plover sightings (grey dots).



The extent of coastline used by individual birds across nine years of monitoring was 47.8 ± 58.0 km, indicating that they do not move far in a lifetime. The species can cross areas of unsuitable habitat (e.g. the rocky coasts around Wilsons Promontory) and water (e.g. 3 km stretch of water across the mouth of Port Phillip Bay and 10 km across Westernport Bay) however the scale of these movements is in the order of 3-16 km. There have been only several larger scale movements across largely unoccupied areas such as between Anglesea and Apollo Bay (~65 km). Regional differences in average distances moved by adults were apparent. South Gippsland (Cape Liptrap to, and including, Wilsons Promontory) and Bellarine regions had high movement rates during the non-breeding season when compared with the Bass Coast and Mornington Peninsula. Regional variation may occur in the movements of adult Hooded Plovers and this would have implications for the effect of coastal development on the species. For example, in the Otway region, movement rates were slightly lower than in other regions, so degradation of a series of 'stepping stone' beaches may be more deleterious to dispersal than in areas with higher movement rates and a more continuous habitat. Fragmentation of the breeding population might occur where habitat is rendered unsuitable for > ~50 km.

Breeding ecology

Hooded Plovers are socially monogamous and both sexes exhibit high levels of parental care (Weston 2000; Weston and Elgar 2005a, 2005b, 2007). There are only two known cases of polygyny, where two females have bred with one male and raised young cooperatively (on the Mornington Peninsula; G. Maguire and G. Ehmke pers. comm.).

The breeding season extends from August to March, but can include July and April dependent on climatic and tidal conditions (Weston 2000; Baird and Dann 2003; BirdLife Australia data). Hooded Plovers generally lay between one and three eggs in a simple scrape of sand, their nest, on the beach above the high tide mark or dune, preferring open areas with sparse to no vegetation for nest placement to have a broad view of potential threats around them in order to minimise predator ambush. They also appear to place nests by dead objects such as driftwood, seaweed or beachcast debris in order to minimise depredation risk (Cribbin 2012).

Once laying of the clutch is complete, laying one egg every 48 hours, the birds incubate for 28 days and use passive nest defense and heavy camouflage of the eggs to reduce the chances of a predator finding the nest. Their nest defense strategy is to leave the nest when a predator approaches and stay distant from the eggs until the predator leaves and it is safe to return. Both sexes share incubation duties and nest attendance rates are as high as 90% in undisturbed conditions (Weston and Elgar 2005a, 2007).

After hatching it takes 35 days until the chicks can fly. During this period, they are active on the beach needing to find their own food, being warned into hiding by calls from their parents. The chicks will run to cover and crouch until the perceived threat is gone and the parents call them out from hiding. The chicks require brooding in their first two weeks as they are unable to thermoregulate. They feed mostly at the water's edge and along the wrack line amongst beach cast seaweed. They commonly run from danger toward the dune and they commonly crouch by or under shelter such as rocks, vegetation or beach debris.

Once a chick reaches 35 days and its wings are strong enough for flight, it is less likely to go into hiding and will more commonly fly from danger. Fledglings can be evicted from the territory once they are capable of flying, especially if there is still time in the season for additional nesting attempts. In other cases, more commonly later in the season, the fledglings can remain on territory as a family unit for months.

Within one breeding season a pair can potentially have up to seven nesting attempts, allowing them multiple opportunities to produce young in such dynamic environments. However, the majority of pairs have an average of 1.8 nesting attempts per season. In some circumstances, a pair starts to display nesting behaviour (courtship and making nest scrapes) but then they cease this behaviour and this has been linked with changes in climatic or tidal conditions. This can continue throughout the entire season with the pair never successfully nesting. This occurs for roughly 4% of pairs in a given season and it is thought to be linked with conditions however, the cues for laying are not

understood (BirdLife Australia data). Pairs are capable of successfully rearing two broods in a season, although examples of this are rare due to the poor breeding success encountered by these birds under current conditions.

Generation Length

Generation length is defined as the average age of parents of a current cohort and reflects the turnover rate of breeding individuals in a population. It is greater than the age at first breeding and less than the age of the oldest breeding individual. It is commonly calculated as (longevity + age at maturity)/2.

Generation length of the Hooded Plover is estimated at 9.85 years based on age of sexual maturity and maximum longevity. Baird and Dann (2003) calculated sexual maturity at 1.7 years, based on the observations of two known age birds and their first breeding attempts. Observations of Kangaroo Island birds suggest that sexual maturity may be earlier. Five birds of known age were paired (copulations observed) aged <12 months. Eleven birds were later recorded breeding at <18months (Dennis and Ball 2013). Weston (2000) reported the proportion of 62 banded juveniles that bred in their first, second, third and fourth years as 17%, 38.7%, 41.7% and 44.4% respectively.

Adults have high survivorship with an annual survival rate of 90.7% based on resightings of colour banded birds (Weston 2003) and are relatively long-lived (estimated to live on average between 10-15 years based on resightings of colour banded birds over time; oldest bird ABBBS data record 18 years). Of the birds that have been banded on Kangaroo Island 63 were aged at >5yrs when last recorded. Of these 63 birds, eight (13%) were known to be 10 years or more in age (Dennis and Ball 2013). Weston (pers. comm. unpublished data) has calculated an average lifespan as less than 11 years based on a long-term database of banded birds.

Population size and Conservation Status

The entire worldwide population of Hooded Plovers (found only in Australia) is estimated at 5500 individuals: 3000 in the eastern subspecies and 2500 in the western subspecies (Garnett *et al.* 2011).

In New South Wales the Hooded Plover is Critically Endangered with approximately 50 birds remaining in the population which has retracted southward in its range (Threatened Species Conservation Act NSW). In both Victoria and South Australia, Hooded Plovers are listed as Vulnerable (South Australian National Parks and Wildlife Act and DSE Advisory List of Threatened Species, respectively) with approximately 550 and 600 individuals in these populations respectively (Ewers *et al,* 2011). They are considered

widespread along the coast line of Tasmania, with approximately 1200 individuals (E. Woehler pers. comm.). The western population is estimated at 2500 individuals.

The Action Plan for Australian Birds 2010 (Garnett *et al.* 2011) is the most recent review of the IUCN criteria and conservation status of Australia's birds. Within this, Hooded Plover as a species is considered Vulnerable according to IUCN Red List Criteria, whereby in the previous Action Plan (Garnett and Crowley 2000) the species was considered Near Threatened, and in the Action Plan of 1990 (Garnett 1992) the species was considered Least Concern. This shows a rapid change in conservation status over the past two decades.

The most recent Action Plan (Garnett *et al.* 2011) also considers the Western and Eastern subspecies of Hooded Plover separately. The Eastern subspecies is listed as Vulnerable (C1 + 2a (ii)) and has been considered so from the first review in 1990 (Garnett 1992; Garnett and Crowley 2000). The lack of change in conservation status here is attributed to the intensive on-ground efforts to improve breeding success in Victoria over the past two decades (Szabo *et al.* 2012). It is stressed that this effort is one that needs to be maintained to mitigate threats related to human disturbances which include people, their dogs, horses and vehicles which are increasing at accelerating rates (Garnett *et al.* 2011).

In March 2012, the Hooded Plover (eastern) was nominated for EPBC listing as Vulnerable. The timing of this nomination is due to the wealth of research carried out in the past decade which has led to increased understanding and scientifically-sound evidence that indicates a small population size, evidence of a past decline and a continuing decline, driven by incredibly poor rates of breeding success. The nomination was accepted for review and the decision will be announced 30th September 2015.

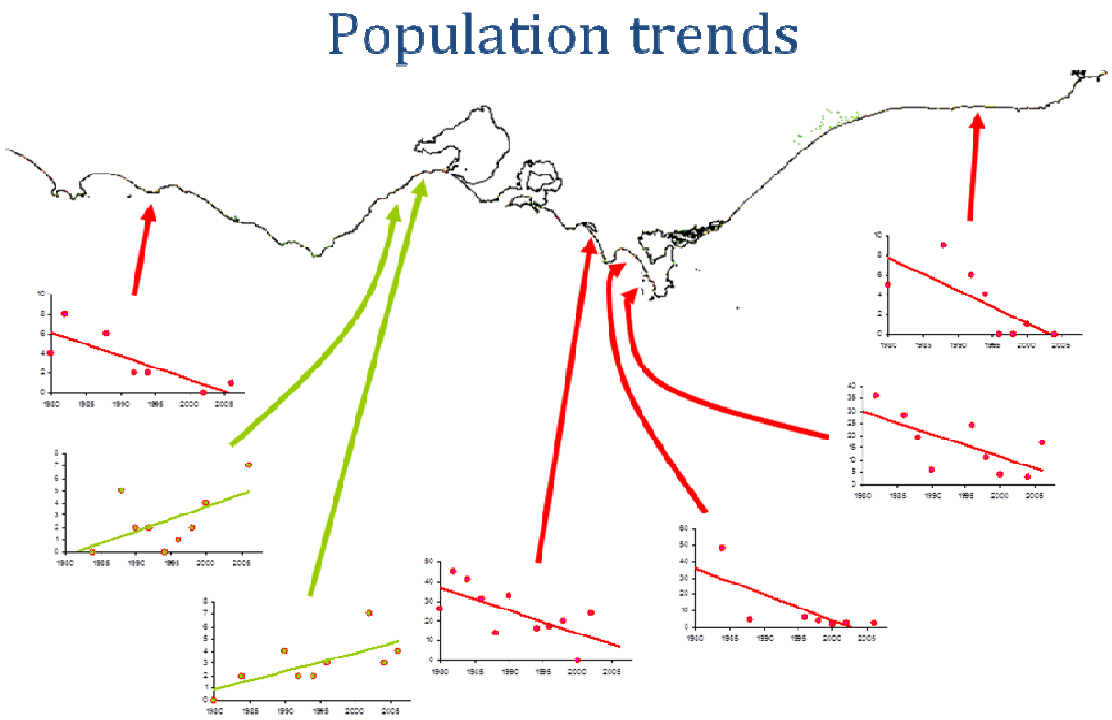
A population in decline

Garnett *et al.* (2011) list a wide range of population declines for Hooded Plover across the south-eastern range of the species. Historically, Weston (1993) estimated a decline of 13% between 1980-1992 across Victoria and Birds Australia (2008) reported a further 12% decline between 2000-2008. At more localised scales, between 1981-1997 the population on Phillip Island was estimated to have declined by 58% (Baird and Dan 2003). Kangaroo Island is believed to have declined by 25% in the 1985-2004 period (Dennis and Masters 2006), and NSW populations have been calculated at around a 55% decline (NSW NPWS pers. comm.).

Biennial counts of Hooded Plovers have been undertaken since 1980 in varying effort across Victoria and South Australia. Glover (2008) reviewed this survey effort and highlighted the inadequacies of this data set for making real comparisons over time of population trends. Only seven sites in Victoria had sufficient data from 1980 to 2005 for trend analysis: five were found to have significant declines in the populations and 2

significant increases (see Figure 2). The magnitude of these changes range from around 40 birds recorded per site in 1980 declining to around 3 birds per site in 2005, whilst the increases are from 0-1 birds in 1980 up to 10 birds recorded in 2005. The increases occurred within the Bellarine Peninsula and Surf Coast (on land managed by Committees of Management and local councils) and relate to increased conservation efforts returning the birds to sites that were formerly occupied. The magnitude of decline in the other five areas significantly outweighs the magnitude of increase, leading to the conclusion that the overall trend for the Victorian population is that of decline (see Figure 2).

Figure 2. Population trends (red indicate declines and green, increases) in seven areas of the Victorian coast where there was comparable data from BirdLife Australia's biennial counts across 1980 to 2005 (taken from Glover 2008).



The most recent biennial population censuses counted 569 adult Hooded Plovers in Victoria in November 2010 (Ewers *et al.* 2011), and 565 adults in November 2012 (Mead *et al.* 2013). In the 2010 census, a number of locations were identified as showing declines in Hooded Plover numbers in comparison to the previous November 2008 survey. There appeared to be significantly fewer Hooded Plovers between the NSW border to Point Hicks, and in The Coorong. Slight increases were reported in other locations, namely between Warrnambool and Yambuk, and between Wilsons Promontory and Waratah Bay. Direct comparison of the number of birds recorded between biennial counts is inappropriate as the survey effort between years has varied. This variation in effort raises the question of whether differences in the data are from real changes in bird

numbers, changes to survey effort, or a combination of both. Ewers *et al.* (2011) controlled for these discrepancies in their analysis of the count data. Their results showed that of the locations where Hooded Plover numbers were declining (Queenscliff to Lorne -11%, South East SA -4%, Discovery Bay -15%, NSW border to point Hicks -41% and The Coorong -44%) all areas but Queenscliff to Lorne had an increased survey coverage of suitable habitat in 2010 compared to 2008. Subsequently these changes in counts were conservatively attributed to actual declining trends in the population. At the other end of the spectrum, the Warrnambool to Yambuk survey area had an increase of 69% in the number of Hooded Plovers recorded, but an increase of 44% of the area covered, and Wilsons Prom to Waratah Bay had an increase of 24% in the number of Hooded Plovers recorded over the same survey area. The overall mean for changes in the count numbers for the entire population was a 9% decline. In other words, while a slight increase in numbers was evident in one part of the coast, the severe declines elsewhere resulted in an overall declining Eastern mainland population by 9% in the space of two years.

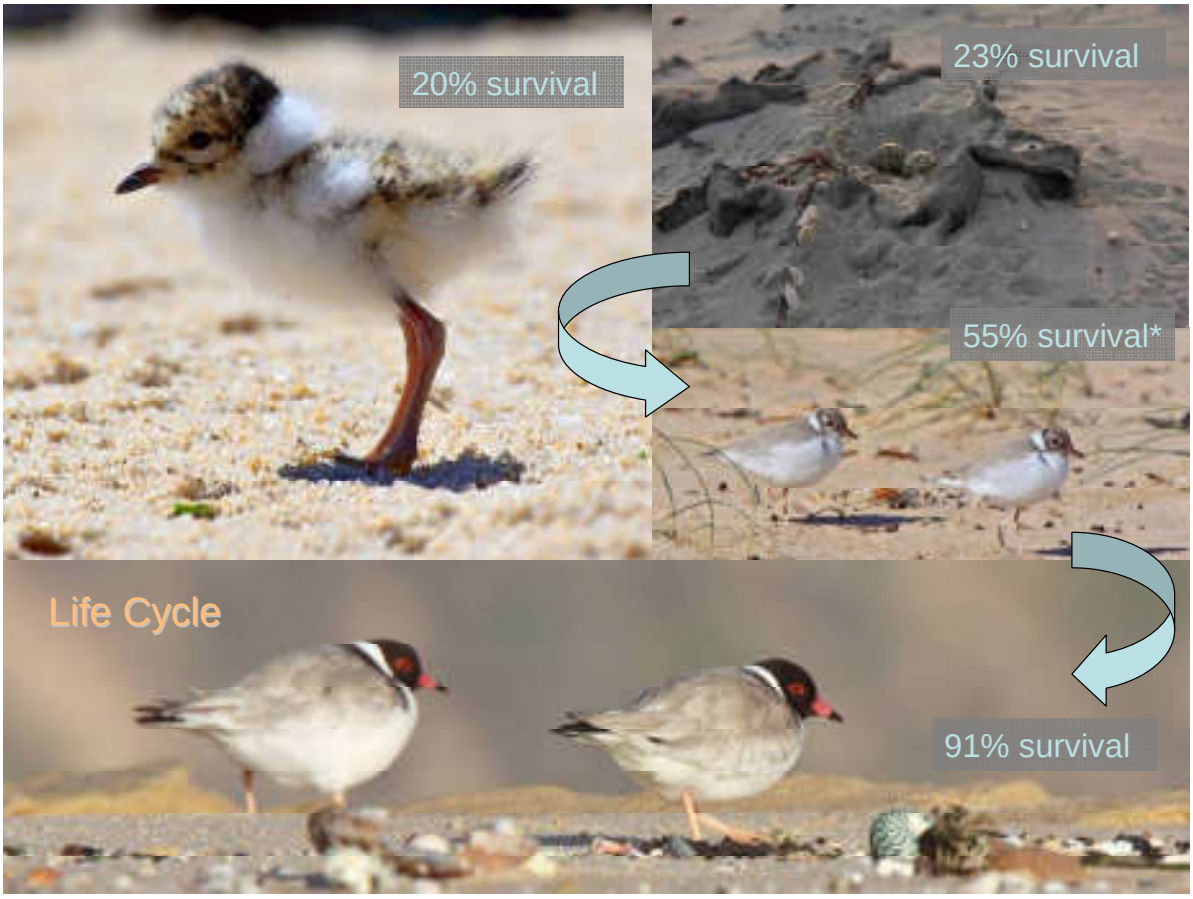
Probability of Extinction

There has not been a Population Viability Analysis (PVA) carried out to date. However, most of the key life history parameters and population size data are becoming available, so that in the next few years, an accurate PVA can be carried out.

Weston (2003) reported in a simplistic model that adults were not long lived enough to replace themselves at current rates. Figure 3 is a life cycle figure showing survival rates at each stage of the life cycle. Adults have high survivorship and are relatively long-lived, however, egg and chick survival are very low (in the order of 20-23%) so that an egg only has a 2.5% chance of progressing to adulthood.

If we review the last 5 years of breeding success data for 52% of the Victorian population, we can see that in 5 years there has been an output of 207 fledglings (for 286 birds) (BirdLife Australia data 2006/2007 to 2010/11). Fledglings have a 55% chance of survival (Weston 2000), reducing this number of recruits to the population to 113.85 in 5 years. This amounts to 22.7 recruits per year. If we account for a population of 550 birds (Ewers *et al.* 2011) and a 9.85 generation length, then it is predicted that 431 recruits are added over 9.85 years to the entire Victorian population. This is assuming no further loss of habitat and that all 550 birds are paired and breeding, which are two unlikely assumptions in the face of continuing habitat degradation and loss of occupancy. This conservative figure would predict a loss of 22% of the Victorian population in 1 generation length.

Figure 3. Life cycle of a Hooded Plover showing survival rates of an individual egg, chick, juvenile and adult. Survival estimates are taken from Weston (2003).



Latest Research Findings

In the past 10 years, our knowledge and understanding of Hooded Plovers has greatly increased. There has been a considerable body of research related to key aspects of the birds' ecology, population demographics, management, and even the social attitudes towards beaches, the birds and their conservation. This has been pivotal in shaping our decision making for management and prioritisation of resources and investment.

BirdLife Australia has collaborated with several universities and education institutions to explore the effectiveness of new management techniques such as chick shelters and conditioned aversion training of predators, and has carried out several social science projects, surveying specific stakeholders or the general beach-using public about use of beaches, knowledge and attitudes towards the species, and support for conservation efforts. Social aspects to conservation are often overlooked, however, for a species with such a high interface with human threats and where conservation management relies heavily on changes in human behaviour, understanding how people perceive and

respond to the species and the managements put in place is critical to the success of on-ground efforts.

Detailed summaries of the most recent studies carried out which have added substantially to our knowledge and have been fed into current management practices and advice throughout this document can be found in Appendix 1. Table 1 below summarises the key findings of these studies.

Table 1. Summary of key research papers and theses relevant to Hooded Plover conservation and management carried out since 2005.

Area of Knowledge	Title of paper	Author/s and year	Key findings
HUMAN DISTURBANCE, NEST CRUSHING AND MANAGEMENTS TO MITIGATE THESE	***Responses of Incubating Hooded Plovers (Thinornis rubricollis) to Disturbance***	Weston and Elgar 2007	Human disturbance caused frequent absences from the nest. HPs responded more strongly to magpies and ravens (i.e. more frequently off nest) and less than expected to walkers HPs had a higher than expected response to off leash dogs than to leashed dogs. Nests on the beach and foredune were more likely to be disturbed than nests in the dune.
	Disturbance to brood-rearing Hooded Plover Thinornis rubricollis: responses and consequences	Weston and Elgar 2005a	31.0% of all brooding bouts were disturbed by a human encounter. Higher levels of disturbance were associated with less chick foraging. Dunes provide important habitat for chicks as a hiding refuge.
	Do temporary beach closures assist in the conservation of breeding shorebirds on recreational beaches?	Weston *et al.* 2012a	93.7% of beach visitors complied with temporary beach closures (TBC), resulting in a reduction in egg-crushing rates within. Human compliance was highest for females and when the density of beach-users was higher (particularly in the middle of the day between 12pm and 2pm).

	Nest Return Times in Response to Static Versus Mobile Human Disturbance	Weston *et al.* 2011	Static people caused substantial disruption to incubation that almost always exceeded 60 min. The probability of plovers returning to nests within 60 min was higher in the treatment that mimicked mobile (e.g., walking) people (85.7%) than in the treatment that mimicked static (e.g., sunbathing) people. TBCs that minimise static human activity are likely to reduce incubation disruptions.
	Perceptions of effectiveness and preferences for design and position of signage on Victorian beaches for the management of Hooded Plovers Thinornis rubricollis	Rimmer *et al.* 2013	684 survey participants indicated that signage is best placed at the beginning of beach access paths or in the carpark. Colourful images and clear definitions of the issue and appropriate behaviour were considered the most effective features of signs. Fines and authoritative language were considered least effective features of signs. Dog walkers respond to personalising the bird and emotive content more strongly.
	Flight initiation distances and determining ecologically meaningful and socially acceptable buffers	Glover *et al.* 2011	Species with higher body masses having longer flight initiation distances (FIDs). The mean FID for Hooded Plover was 41.12 ± 6.06 m with a minimum distance of 17 m and a maximum of 70 m recorded for the 8 pairs approached.

	A review of flight-initiation distances and their application to managing disturbance to Australian birds	Weston *et al.* 2012b	A review of FID for 250 Australian birds. The Hooded Plover had the highest positive residual value in a linear regression of FID on mean body mass – this means that the Hooded Plover showed the highest response to a human approach of any species in its size class, thus is most sensitive to human disturbance.
CHICK SURVIVAL	***Artificial shelters: design, use and effectiveness at improving chick survival***	Maguire *et al.* 2011b	A simple teepee design offered a 9° C thermal benefit on average, was least conspicuous to people, had no approaches by avian predators in 157 passes, and was the lightest to carry in the field and easiest to stack for transportation. High rates of shelter use by HP chicks across years (33-41% of broods). Of 10 broods with access to only natural shelter, 10.0% fledged, while of 11 broods with access to an artificial shelter, 81.8% fledged successfully. Fledging success data from additional broods in the 2006/2007 and 2007/2008 breeding season, revealed that 22.4% that did not have access to artificial shelter survived to fledge, while 65.2% that had access to artificial shelters survived to fledge.
COLOUR BANDING MOVEMENTS AND SPACE USE	***Manage one beach or two? Movements and space-use of the threatened Hooded Plover (Thinornis rubricollis) in south-eastern Australia***	Weston *et al.* 2009	194 birds tracked for up to 9 years. The maximum movement recorded was 330.8 km. The extent of coastline used by individual birds was 47.8 ± 58.0 km. 96.2% of the observations were less than 100m inland of the coastline; the furthest inland Hooded Plovers were observed was 1500m inland at Lake Victoria.

			In the Otway region, movement rates were slightly lower than in other regions, so degradation of a series of 'stepping stone' beaches may be more deleterious to dispersal than in areas with higher movement rates and a more continuous habitat. HPs use distinctive flocking sites during non-breeding season. These are just as valuable to conserve as breeding sites. Breeding territories were 36.7 ± 5.7 ha and overlapped from year to year.
NEST PREDATORS, MICRO-HABITAT SELECTION AND PREDATOR CONTROL	***Clutch fate and success of the Hooded Plover (Thinornis rubricollis)***	Mead 2012	Nest fates were able to be assigned for 64 HP nests (cameras deployed on 81 nests in total). 26 hatched (41%) and 38 failed to hatch (59%) for the following reasons: depredation, tidal inundation, and crushing by human. Nests were predominately depredated by foxes (26%, n=10), ravens (24%, n=9) and magpies (16%, n=6). 18% of nests were lost to tide, mostly in far west Victoria. More nests failed on the beach than in other habitat types.
	Dune-nesting plovers select nest sites to minimize the risk of clutch depredation	Mead *et al.* in prep	62 artificial nests containing treated quail eggs were established in dune systems across the Victorian coast. The likelihood of an artificial nest being depredated was significantly influenced by two variables: distance to nearest dead object (e.g. stick, seaweed) and the amount of grass cover. Real nests were more likely to be closer to dead objects than those sites selected by a researcher.

			Real nests were more likely to have less grass cover than those sites selected by a researcher. Real Hooded Plover nests were significantly closer to the foredune than artificial nests. HPs are selecting very specific spots for their nests presumably to reduce likelihood of depredation.
	Conditioned aversion to reduce the likelihood of egg depredation	Maguire *et al.* 2009	Model (quail) eggs treated with a potential CA-inducing chemical (sodium carbonate) and control (quail) eggs free of the agent were exposed to fox depredation for 28 days. After the first depredation event by foxes, the rate and likelihood of fox depredation was significantly lower in treated eggs than in control eggs. CA seemed to be effective at reducing fox take of eggs across 28 days.
	An assessment of the efficacy of using conditioned aversion of foxes to the eggs of beach-nesting birds: a broad scale test	Cribbin 2012	Repeat of the above study across a broader geographic area and to trial two different delivery types. A low species-specificity of predators taking CA-treated eggs was found, that is, foxes took 9.7% of arrays, ravens and rodents took 80.0%; n = 145 arrays. None of the CA strategies tested (one nest with 28 and 42 day training periods, and a six nest 'saturation' array) produced a detectable aversion by avian or mammalian predators. CA does not appear to work on a broad scale, largely due to nests being taken by non-target predators.

WEEDS AND BROADSCALE HABITAT SELECTION	***Nesting habitat selection and the impact of weeds***	Cousens *et al.* 2013	Overall, vegetation cover was sparse around nests (31.74 ± 5.52%; 0.00 – 42.50%; n = 64) with Hooded Plovers tending to select areas with a high ratio of sand and low ratio of vegetation for nest placement. Hooded Plover nests were distanced between 1 cm (Sea Wheat-grass) and 5.6 m (Marram Grass) from weed species. Hooded Plover nests were located closer to weed species than non-weed species. This is likely to be related to the prevalence of weed species versus native species in coastal habitats (double the amount of cover).
	Geomorphology and weeds	Cousens *et al.* 2013	Sea rocket is unlikely to have much direct effect on dune morphology, although it may have an indirect influence by facilitating the establishment of other less salt tolerant species. Marram grass is the dominant species between Port Fairy and Warrnambool while sea wheat-grass dominates between Wonthaggi and Darby Beach. Marram grass forms foredunes that are typically higher, steeper and narrower than that formed by either sea wheat-grass or hairy Spinifex. The height and steepness of the seaward face means that erosion of marram grass dunes leads to higher dune scarps. Sea wheat-grass can rapidly form relatively wide, continuous alongshore foredunes, which are probably are able to form at lower elevations than those associated with any other foredune species present on the Victorian coast. This may lead to a narrowing of the back-beach and an increase in dune erosion and the resulting formation of dune scarps.

	Habitat modelling: what makes a beach suitable for Hooded Plovers?	Ehmke *et al.* in prep	Using 58 sites across the Victorian coast, 28 where Hooded Plovers are present and 30 where they are absent, a series of variables likely to drive habitat suitability were measured within a 500 metre radius of each point. The factors driving the presence of Hooded Plovers on the Victorian coast were: Proportion reef habitat (0.98); Proportion foredune habitat (0.92); Presence of dune habitat (0.89); Proportion rock habitat (0.62), and; Rugosity of the beach (0.42).
	The foraging and diet of non-breeding Hooded Plovers Thinornis rubricollis in relation to habitat type.	Weston 2007	A study of the foraging behaviour and diet of Hooded Plovers in the non-breeding season in 3 different habitats. The diet of coastal birds was dominated by crustaceans and insects whereas birds on salt lakes primarily, and almost exclusively, consumed *Coxiella* spp., an endemic gastropod (snail).
SOCIAL SCIENCE STUDIES	***Being beside the seaside: Beach use and preferences among coastal residents of south-eastern Australia.***	Maguire *et al.* 2011a	Surveyed 385 people (13.8% of 2800 coastal residents) from south-eastern Australia to examine their use of beaches and the features that are important in their choice and enjoyment of a beach destination. There appears to be a distinct dichotomy in use of 'local' versus 'non-local' beaches, where local beaches are visited more frequently, throughout more of the year, outside working hours and by smaller groups of people, compared with 'non-local' beaches. Overall, respondents valued clean, uncrowded beaches with opportunities to view wildlife, but also desired facilities (e.g. toilets, shade, life savers, food outlets).

	Stakeholder Perceptions of Threatened Species and Their Management on Urban Beaches	Maguire *et al.* 2013	Maguire *et al.* surveyed 579 recreationists regarding management of the threatened Hooded Plover. Overall, inconvenience was low while awareness and support for plover conservation were high. Dog walkers reported more inconvenience associated with exclusions and regulations.
	Birds and Beaches, Dogs and Leashes: Dog Owners' Sense of Obligation to Leash Dogs on Beaches in Victoria, Australia	Williams *et al.* 2009	Leashing of dogs can significantly improve conservation outcomes for Hooded Plovers, but few dogs are leashed on beaches: (82% of 2,847 dogs on Victorian beaches, 1994–2008). Surveyed a total of 385 dog owners across Victoria to explore their sense of obligation to leash dogs on beaches. Most dog owners see no conflict between off leash dog exercise and wildlife conservation. In general, respondents considered their own dog to be much less of a threat to wildlife and people than they considered dogs in general. Dog owners were more likely to feel obliged to leash their dog when they believed other people expected dogs to be leashed.

Current knowledge gaps and research priorities

There are key research priorities to ensure that conservation management and investment in the Hooded Plover and beach habitats is highly effective and successfully recovers and maintains the population over time (i.e. is adaptive).

The following are identified as knowledge gaps that are the current research priorities (an asterisk indicates that these are currently underway):

- Diet and food availability across the coast*: discovering if there is variation in food availability across coastal habitats in time and space, which will allow us to identify the best habitats for Hooded Plovers and suitable but unoccupied habitat.
- Avian predators*: understanding any factors which increase the detection of nests or chicks by these predatory birds, and uncovering techniques for minimising impacts of these native predatory birds.
- Chick fates: there is very limited information on the actual fates of chicks. Most evidence for loss of chicks is circumstantial and the likelihood of observing their fate is very low but has occurred over the years (i.e. depredation by silver gull, kestrels, domestic dogs, magpies, and crushed in the nest by a walker). Filling this knowledge gap is dependent on the development of and sourcing effective remote surveillance technology or miniature tracking devices (light enough not to impact the survival of chicks).
- Mapping of all threats (human, predators, weeds) overlayed against Hooded Plover distribution.
- Juvenile survival and dispersal*: achieved through banding of chicks and juveniles over successive breeding seasons, and following their movements and pairing over time.
- Identification of the causes of range contraction in the eastern range of the species (i.e. NSW), particularly if this threatens to further contract to East Gippsland.
- Population viability analysis (PVA): once we have a better understanding of juvenile survival and dispersal, and carrying capacity of coasts, we will have the final parameters for carrying out an accurate PVA. This is likely to occur in the next two years.
- Trialing dune restoration, i.e. removal of Marram and/or Sea Wheat-grass, is a priority for sections of the coast which are losing habitat suitability for the species, e.g. the coast between Warrnambool and Yambuk. Trials into removing Marram grass should be instigated to investigate the short and long term effectiveness of different weed removal techniques and subsequent short and long term use of rehabilitated dunes by Hooded Plovers in these areas. The determination of how rates of colonisation by invasive plants can be reduced or controlled (e.g., through changed fire regimes), would be worthwhile.
- Visitor numbers on beaches (pedestrian access) and how this varies in space and time. In order to better understand the intensity of human impacts at sites and to optimise the timing of patrols and management investment, it is essential to understand the peaks in use of different beaches across the coast, particularly in parks with high visitation rates.
- Informal access points: mapping of informal access points and understanding why these arise and how to limit the formation of informal access tracks, would be beneficial to tackling issues of coastal erosion, crushing of nests in dunes and enable identification of

areas where fencing and signing of nests needs to take into account access from the dune side.

- Investigation into the development of 'plover friendly' coastal armouring may become useful in the future if armouring coasts against rising sea levels results in widespread erection of sea walls and dune matting, etc.

Chapter 2 – Importance of the Parks Victoria Estate

Chapter 2 explores BirdLife Australia's long term data set on population numbers to identify important areas of coast for the species and in particular, the importance of the Parks Victoria estate. This chapter then further explores the breeding success of Hooded Plovers across regions of Victoria, exploring the productivity of pairs on the Parks Victoria estate.

Important populations

Based purely on the density of adult Hooded Plovers as revealed from BirdLife Australia's biennial population counts across all suitable ocean beach habitat in SA, Vic and NSW, Ewers *et al.* (2011) highlight important stretches of coast for the Hooded Plover on the eastern mainland as:

- Far West Victoria (Warrnambool to Portland) (2.9 birds/km)
- Mornington Peninsula (2.83 birds/km)
- Bass Coast (1.91 birds/km)
- Kangaroo Island
- Yorke Peninsula

Thus, three of the most important areas for the Hooded Plover across its Eastern mainland range are primarily managed by Parks Victoria within multiple parks of varying land reservation status. This signifies the importance of these areas for the species at a National level.

Another method for identifying priority sites for birds is through BirdLife International's Important Bird Area (IBA) criteria, namely areas which:

- Hold significant numbers of one or more globally threatened bird species;
- Are one of a set of sites that together hold a suite of restricted-range species or biome-restricted species;
- Have exceptionally large numbers of migratory or congregatory species.

There are 13 identified IBAs in South Australia, Victoria and Tasmania for the Hooded Plover (eastern). These sites are believed to be important to the long term conservation of the species and are:

- Coffin Bay (SA)
- The Coorong (SA)
- Kangaroo Island (SA)
- Discovery Bay to Picaninnie Ponds (SA/VIC)
- Yambuk (VIC)
- Port Fairy to Warrnambool (VIC)
- Phillip Island (VIC)
- Corner Inlet (VIC)
- Eastern Flinders Island (TAS)
- King Island (TAS)

- St Helens (TAS)
- North-west Tasmania and Marion Bay (TAS).

This method also identifies the area in far west Victoria from the border of SA to Port Fairy as important to the species. The IBA criteria, however, have limited relevance for highly dispersed species as the criteria are designed for congregatory species and the method is highly dependent on where boundaries are drawn.

The territorial social structure and highly dispersed nature of Hooded Plovers makes it difficult to prioritise geographic areas without further understanding the exchange of individuals across the range, the impact of edge effects and current levels of genetic diversity across this range. A review of movements of colour banded birds (Weston *et al.* 2009) reveals that there may be dispersal barriers along coasts where long stretches of unsuitable habitat are encountered by dispersing birds and this limits the exchange of individuals between geographically separated areas. This may mean that populations are managed on the basis of this separation, which would give rise to the following: Booderee National Park Jervis Bay NSW to Kioloa NSW, Wallaga Lake NSW to Gippsland lakes VIC, Wilsons Prom to Surf Coast, Otways to South Australia.

In Victorian terms, potential dispersal barriers may mean that management of Hooded Plovers needs to focus on three key regions (West, Central and East), ensuring that there is a spread of effort so that at least the highest priority threats and actions within these three regions are addressed.

Importance of the Parks Victoria Estate for Hooded Plovers

On the Eastern mainland, Parks Victoria is the single most important land manager for Hooded Plovers, responsible for 31.6% of the population occurring across SA, Vic and NSW. In the other states, State Government agencies are responsible for managing a lower percentage of their statewide populations of Hooded Plovers. For example in SA, the birds occur on land managed by a broader range of agencies, including multiple local councils, the Department of Environment, Water and Natural Resources (DEWNR), Indigenous Traditional Owners and private landholders. In NSW, management agencies include multiple local councils, the NSW National Parks and Wildlife Service, the Federal Government, and Indigenous Traditional Owners.

Ninety-six percent of Victoria's coast is in public ownership (Victorian Coastal Council 2008). In Victoria, Parks Victoria is the primary land manager of ocean beach coastline occupied by the Hooded Plover, responsible for 76.1% of the Victorian Hooded Plover population (Table 2). The additional 23.9% of the Victorian population is managed by various local councils, Committees of Management and the Department of Sustainability and Environment, and in rare circumstances, the birds occur on beaches that are privately owned to the high tide mark.

Table 2 below explores the distribution of Hooded Plover occupancy, whereby the bulk of Hooded Plovers on the Parks Victoria estate occur on the central (33%) and west (29%) coastlines of Victoria. If a comparison is made between historical data of the proportion of Hooded Plovers in selected National and Coastal Parks across Victoria (Lane 1981), and current

data sources, this reveals that there has been a major shift in the distribution of Hooded Plovers over time (Table 3). In 1981, Croajingalong National Park held a high proportion of Hooded Plovers, but now holds the lowest proportion of the five selected parks. This may reflect habitat changes or be related to the species decline at the eastern edge of its range (i.e. southern NSW). The reverse trend is true for the Mornington Peninsula National Park, which in 1981 held the lowest proportion of the five parks, but it now holds the highest proportion of Hooded Plovers (Table 3). It is therefore critical to monitor, interpret and feed back our knowledge of important habitat areas into conservation management of the species over time.

Table 2. The distribution of the Hooded Plover population on the Victorian coast according to Parks Victoria (PV) managed land and non-Parks Victoria managed land (i.e. managed by various local councils, Committees of Management and the Department of Sustainability and Environment).

	NUMBER OF HOODED PLOVERS ON PV MANAGED LAND (%)	**NUMBER OF HOODED PLOVERS ON NON PV MANAGED LAND (%)**	**TOTAL**
East	84 (14.7%)	10 (1.7%)	94
Central	190 (33.4%)	62 (10.9%)	248
West	159 (28%)	64 (11.3%)	227
Total	433 (76.1%)	136 (23.9%)	569

Table 3. Comparison of the proportion of the Victorian Hooded Plover population in selected National Parks between 1980 data (after Lane 1981), 2010 biennial count data (Ewers *et al.* 2011) and the most recent pair distribution data (combined BirdLife Australia biennial count and pair monitoring databases). In brackets is the number of birds. The five parks are ranked relative to one another, from highest (1) to lowest percentage of the population (5).

PARK	**1980 % VIC POP**	**1980 RANK**	**2010 % VIC POP**	**2010 RANK**	**2013 % VIC POP**	**2013 RANK**
Discovery Bay Coastal Park	7.9%	3	7.2% (41)	2	5.3% (30)	2
Mornington Peninsula National Park	1.5%	5	10.0% (57)	1	12% (68)	1
Wilsons Promontory National Park	10.5%	2	4.4% (25)	3	3.87 (22)	4
Gippsland Lakes Coastal Park	4.6%	4	1.1% (6)	5	2.46 (14)	5
Croajingolong National Park	12.7%	1	4.2% (24)	4	4.57 (26)	3

The twenty-eight parks and reserves managed by Parks Victoria have been ranked according to the number of Hooded Plovers they contain (Table 4). Mornington Peninsula National Park and Belfast Coastal Reserve have the highest number of Hooded Plovers and make up 12% (68 individuals) and 9.1% (52 individuals) of the Victorian population, respectively. These account for 15.7% and 12% of the population occurring on Parks Victorian land. The next six parks each hold between 5 and 10% of the total Parks Victoria population and include Kilcunda – Harmers Haven Coastal Reserve, Cape Liptrap Coastal Park, Discovery Bay Coastal Park, Croajingolong National Park, Great Otway National Park and Wilsons Promontory National Park (containing 22-38 individuals). Together, these eight parks make up 50% of the total Victorian population, highlighting their significance to the State's population. The additional 50% of birds are spread across twenty parks, and it is likely that the contribution of these additional twenty parks plays a role in maintenance of the population's genetic diversity, as well as to maintenance of the species range and capacity for dispersal.

Figures 4 to 6 show the distribution of Hooded Plovers across the Victorian coast for Parks Victoria and non-Parks Victoria managed land, differentiated according to two different data sources: 1) sites with at least one bird as detected in the 2008 and 2010 biennial counts and 2) pairs monitored as part of BirdLife Australia's Beach-nesting Birds program (2006-2013). The latter is the more reliable, as these are confirmed breeding sites.

Table 4. The park location, number of birds within each park, with the percentage of the Victorian population and the percentage of the Parks Victorian population of Hooded Plovers presented and ranked from highest proportion to lowest proportion (BirdLife Australia database 2013). * Sites within this park were divided into Central and West due to the zones used during data collection for the Beach-nesting Birds project. The sites around Anglesea and Aireys Inlet fall into the Surf Coast zone and were therefore classified as central, while the sites around Blanket Bay and Johanna are within the Otways zone and therefore were classified as West.

Park Name	Location	# Birds	% Vic Pop.	% Pv Pop.	Rank
Mornington Peninsula National Park	Central	68	11.95	15.70	1
Belfast Coastal Reserve Coastal Reserve	West	52	9.14	12.01	2
Kilcunda - Harmers Haven Coastal Reserve	Central	38	6.68	8.78	3
Cape Liptrap Coastal Park	Central	32	5.62	7.39	4
Discovery Bay Coastal Park	West	30	5.27	6.93	5
Croajingolong National Park	East	26	4.57	6.00	6
Great Otway National Park	Central, West*	6,18	4.22	5.54	7
Wilsons Promontory National Park	Central	22	3.87	5.08	8
Eumeralla (Yambuk) Coastal Reserve	West	16	2.81	3.70	9
Narrawong Coastal Reserve	West	14	2.46	3.23	10
Gippsland Lakes Coastal Park	East	14	2.46	3.23	10
Bay Of Islands Coastal Park	West	13	2.28	3.00	11
Nooramunga Marine & Coastal Park	East	12	2.11	2.77	12
Marlo Coastal Reserve	East	10	1.76	2.31	13
Cape Conran Coastal Park	East	10	1.76	2.31	13
Port Campbell National Park	West	8	1.41	1.85	14
Point Nepean National Park	Central	8	1.41	1.85	14
Yambuk F.F.R.	West	6	1.05	1.39	15
Bunurong Coastal Reserve	Central	6	1.05	1.39	15
Punchbowl Coastal Reserve	Central	4	0.70	0.92	16
Mcloughlins Beach - Seaspray Coastal Reserve	East	4	0.70	0.92	16
Lakes Entrance - Lake Tyers Coastal Reserve	East	4	0.70	0.92	16
Elliot River - Addis Bay Coastal Reserve	West	2	0.35	0.46	17
Eagle Rock Marine Sanctuary	Central	2	0.35	0.46	17
Lonsdale Lakes W.R	Central	2	0.35	0.46	17
Port Phillip Heads Marine National Park	Central	2	0.35	0.46	17
Shallow Inlet Marine & Coastal Park	East	2	0.35	0.46	17
Ewing Morass W.R	East	2	0.35	0.46	17

Figure 4. Distribution of Hooded Plovers across the west coast of Victoria, distinguishing between different sources of data (biennial count data and pair monitoring data) and Parks Victoria and non-Parks Victoria land.

Figure 5. Distribution of Hooded Plovers across the central coast of Victoria, distinguishing between different sources of data (biennial count data and pair monitoring data) and Parks Victoria and non-Parks Victoria land.

Figure 6. Distribution of Hooded Plovers across the east coast of Victoria, distinguishing between different sources of data (biennial count data and pair monitoring data) and Parks Victoria and non-Parks Victoria land.

Land reservation status

Across the Parks Victoria estate, the land reservation status of parks in which Hooded Plovers occur in varies greatly (see Table 5). The majority of pairs occur in National Parks (39.2%) and Coastal Reserves (34.6%), which represent two extremes in terms of level of protection offered (Table 6). Coastal reserves commonly are unregulated crown land and this can strongly impact the resultant threat levels experienced by the birds in these areas (see discussion on page 127). Land reservation status, however, is not always a reflection of 1) the intensity of threats that the birds will experience (i.e. birds in National Parks will not necessarily be facing lower threat levels than birds on coastal reserves, see Appendix 7), or 2) the management attention the species receives, as this is often driven by community-based volunteers. Regulations, such as dog and horse access, can also vary greatly across and even within parks with the same land reservation status. Compliance with regulations is an additional consideration, because while a regulation may be in place this does not guarantee it will be abided by and thus, that particular threat may still be effectively unaddressed.

Table 5. The number of Hooded Plovers (individual birds) and number of breeding pairs monitored by BirdLife Australia's Beach-nesting Birds Program, according to Park. The type of park is specified (land reservation status), and parks are presented in order from west to east along the Victorian coast.

PARK NAME	TYPE	# BIRDS	# PAIRS MONITORED
Discovery Bay Coastal Park	Other Park - Schedule 3, National Parks Act	30	0
Narrawong Coastal Reserve	Coastal Reserve	14	2
Eumeralla (Yambuk) Coastal Reserve	Coastal Reserve	16	3
Yambuk F.F.R.	Nature Conservation Reserve - Flora And Fauna Reserve	6	0
Belfast Coastal Reserve Coastal Reserve	Coastal Reserve	52	25
Bay Of Islands Coastal Park	Other Park - Schedule 3, National Parks Act	13	3
Port Campbell National Park	National Park - Schedule 2, National Parks Act	8	3
Great Otway National Park	National Park - Schedule 2, National Parks Act	24	10
Elliot River - Addis Bay Coastal Reserve	Coastal Reserve	2	0
Eagle Rock Marine Sanctuary	Marine Sanctuary - Schedule 8, National Parks Act	2	0

PARK NAME	TYPE	# BIRDS	# PAIRS MONITORED
Lonsdale Lakes W.R	Nature Conservation Reserve - Wildlife Reserve (No Hunting)	2	0
Port Phillip Heads Marine National Park	Marine National Park - Schedule 7, National Parks Act	2	1
Point Nepean National Park	National Park - Schedule 2, National Parks Act	8	5
Mornington Peninsula National Park	National Park - Schedule 2, National Parks Act	68	32
Punchbowl Coastal Reserve	Coastal Reserve	4	2
Kilcunda - Harmers Haven Coastal Reserve	Coastal Reserve	38	20
Bunurong Coastal Reserve	Coastal Reserve	6	3
Cape Liptrap Coastal Park	Other Park - Schedule 3, National Parks Act	32	10
Shallow Inlet Marine & Coastal Park	National Parks Act Schedule 4 Park or Reserve	2	0
Wilsons Promontory National Park	National Park - Schedule 2, National Parks Act	22	3
Nooramunga Marine & Coastal Park	National Parks Act Schedule 4 Park Or Reserve	12	0
Mcloughlins Beach - Seaspray Coastal Reserve	Coastal Reserve	4	0
Gippsland Lakes Coastal Park	Other Park - Schedule 3, National Parks Act	14	6
Lakes Entrance - Lake Tyers Coastal Reserve	Coastal Reserve	4	2
Ewing Morass W.R	Natural Features Reserve - Wildlife Reserve (Hunting)	2	0
Marlo Coastal Reserve	Coastal Reserve	10	4
Cape Conran Coastal Park	Other Park - Schedule 3, National Parks Act	10	4
Croajingolong National Park	National Park - Schedule 2, National Parks Act	26	1
		433	**139**

Table 6. The percentage of birds falling within Parks Victoria managed land according to land reservation status.

Park type	**% Parks Victoria Hooded Plover population (n=433)**
National Park	39.26%
Coastal Reserve	34.64%
Coastal Parks	22.86%
Nature Conservation Reserve - Flora and Fauna Reserve	1.39%
Marine Sanctuary and Parks	0.92%
Natural Features Reserve - Wildlife Reserve (hunting)	0.46%
Nature Conservation Reserve - Wildlife Reserve (no hunting)	0.46%

Regional Hooded Plover breeding success

Hooded Plover population declines are largely driven by poor breeding success and for this reason it is essential to monitor breeding output in order to understand the extent of the problem, what is driving it, and whether management efforts are successfully alleviating threats and improving breeding success. We also need to identify whether there are spatial trends in productivity, that is, sites/regions which successfully recruit young into the population versus sites/regions which act as 'sinks' (i.e. have Hooded Plovers present and attempting to breed, but never successfully produce young).

Since August 2006, BirdLife Australia's Beach-nesting Birds program has coordinated the monitoring of an average of 96 Hooded Plover pairs along the Victorian coast. The number of pairs monitored in each region of the coast varies considerably and this relates largely to how dense the birds are in the different regions. West Victoria (Warrnambool to Narrawong), the Mornington Peninsula and South Gippsland have high densities of Hooded Plovers and consequently there is higher monitoring effort within these areas. The birds are much sparser and difficult to access in East Gippsland, around the rocky Shipwreck coast, and along the Otway coast. Visits to pairs in East Gippsland and Shipwreck Coast have been infrequent so we exercise caution in interpreting this data as there may be a bias towards successful nests as these last over a longer period and are more likely to be detected. We therefore concentrate on four key regions with large numbers of pairs and/or where there were at least 10 visits per pair per season.

The best measure of breeding success for Hooded Plovers is the number of fledglings produced standardised by the number of breeding pairs monitored. Figure 7 displays the mean fledglings per pair across five successive seasons (2006/07, 2007/08, 2008/09, 2009/10, 2010/11) and the error bar reflects the degree of variability between seasons. Four regions in Victoria were used in this comparison as they have had between 80-100% of breeding pairs monitored with regular visits during the breeding season. They also represent high density areas for Hooded Plovers, particularly West Victoria (27 ± 4

pairs monitored), Mornington Peninsula (24 ± 2 pairs monitored) and South Gippsland (20 ± 3 pairs monitored). Bellarine Peninsula has 8 ± 1 pairs monitored over time and is included due to the high level of monitoring in this region.

There has been strong variability in fledging success in west Victoria and South Gippsland over the five seasons (Figure 7), this being predominantly driven by variation in hatching success (Table 7) and the prevailing influence of tides. Mornington Peninsula has had the lowest average breeding success of the four Victorian regions, and this varies little over time (with the lowest standard error), suggesting that there are significant threats that are not responding well to management investment over time. The Bellarine Peninsula appears to have a steady output of fledglings over time for the 8 pairs present along this coastline, and this fledgling production sits comfortably within the standardised average.

Figure 7. The mean (± standard error) number of fledglings produced per pair across five seasons of monitoring in four regions of Victoria.

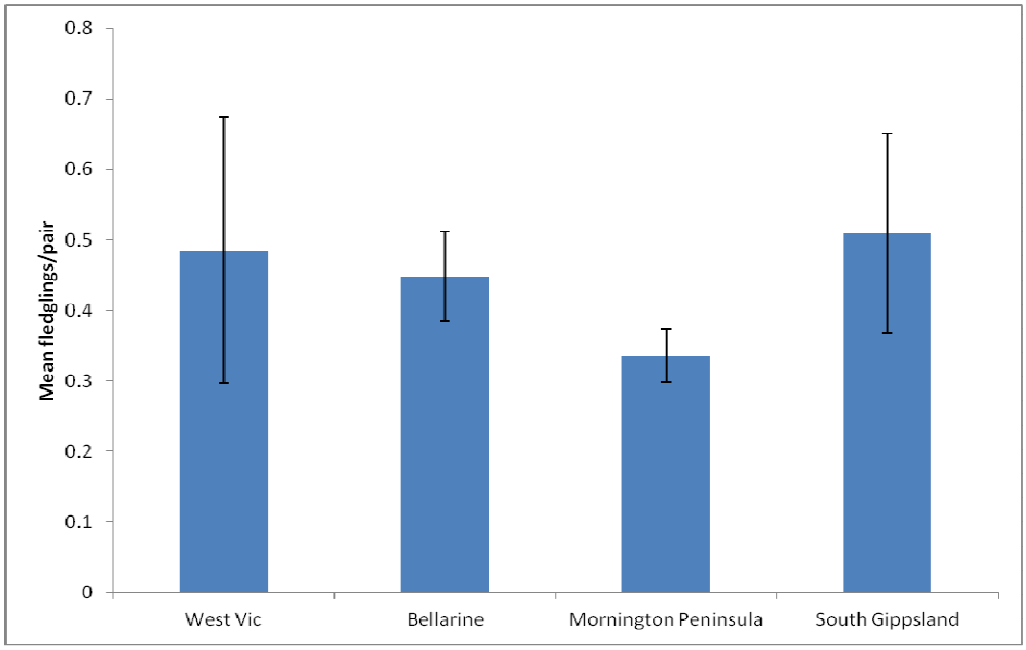


Table 7 provides a comprehensive overview of each facet of breeding success across all the regions where monitoring occurred over five breeding seasons, including the number of nesting attempts per pair (2.1 attempts on average); hatching success (43.3% on average), and the number of fledglings produced per season (41.2 on average across all regions combined). Average hatching success seems to be lowest in South Gippsland and West Victoria, which can be largely explained by higher losses of nests to tidal inundation.

An important facet of breeding success is Hooded Plover chick survival (i.e. chicks that survived 5 weeks to fledging). Figure 8 reveals that South Gippsland has the highest rates of chick survival experienced across the Victorian coast (average 42%). West Victoria (31%) and the Bellarine (29%) have similar rates, although chick survival

appears to be more variable in West Victoria. Mornington Peninsula experiences the lowest rates of chick survival at 18%. Table 7 shows that hatching success on the Mornington Peninsula is comparative to other regions, and so the significantly lower breeding success for this region appears to be driven by low chick survival. Currently chick fates are largely unknown (see page 41). We can however, explore the relationship between the presence and intensity of different threats to investigate which threats appear to be driving low chick survival (see page 81).

Figure 8. Chicks surviving to fledge as a percentage of eggs that hatched successfully, across five seasons and four regions of Victoria.

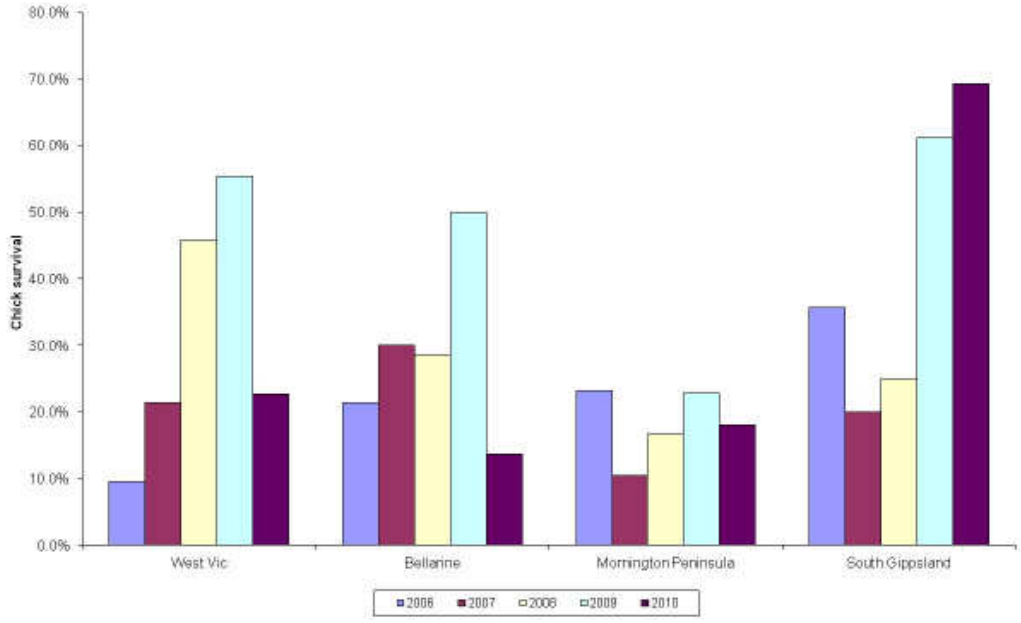


Table 7. Measures of breeding success for pairs monitored across five breeding seasons, broken down into eight regions across the Victorian coastline.

Measure	West Victoria	Shipwreck Coast	Otways	Anglesea	Bellarine	MP	South Gippsland	East Gippsland
# pairs monitored	27.4 ± 4.1	2.8 ± 0.7	3.6 ± 0.2	2.6 ± 0.4	8.2 ± 0.8	24.0 ± 1.7	20.4 ± 3.6	7.8 ± 2.1
# nests	44.6 ± 10.2	4.4 ± 0.7	8.8 ± 1.6	6.0 ± 0.6	14.6 ± 2.8	48.2 ± 2.2	31.4 ± 4.0	8.0 ± 2.8
# nests per pair	2.0 ± 0.1	2.0 ± 0.4	2.6 ± 0.4	2.6 ± 0.3	1.8 ± 0.2	2.0 ± 0.1	1.6 ± 0.1	2.1 ± 0.7
% nests hatching	34.4 ± 5.9	58.8 ± 18.4	38.0 ± 9.3	60.0 ± 10.3	43.3 ± 8.1	39.5 ± 1.7	28.6 ± 5.4	43.4 ± 11.5
% hatched nests fledging	49.3 ± 10.4	53.3 ± 22.6	40.7 ± 16.9	48.0 ± 5.6	54.7 ± 13.7	30.7 ± 4.6	68.6 ± 8.2	30.0 ± 13.3
% nests fledging	18.9 ± 6.0	46.4 ± 20.1	14.6 ± 5.4	29.2 ± 6.7	20.4 ± 3.7	11.9 ± 1.6	20.1 ± 4.4	15.0 ± 6.3
# fledglings	11.0 ± 5.2	2.8 ± 1.3	1.0 ± 0.5	2.4 ± 0.4	3.4 ± 0.2	7.8 ± 0.8	10.2 ± 4.1	2.6 ± 1.6
# fledglings/pair	0.5 ± 0.2	0.8 ± 0.3	0.3 ± 0.2	1.1 ± 0.2	0.4 ± 0.1	0.3 ± 0.0	0.9 ± 0.1	0.3 ± 0.2

Nest fates

Data collected by BirdLife Australia's Beach-nesting Birds Program over five seasons revealed a number of fates as interpreted by circumstantial evidence, that is, tracks of predators around the nest, signs of tidal inundation, or extreme weather or disturbance occurring on the day of the nest failure (Table 8). Of 829 nests monitored over five seasons (2006/07 - 2010/11 season), 37.15% of nests hatched. Forty two percent of nest failures were unable to be linked with a cause due to lack of evidence around the empty nest site. Failure from tidal inundation was the most highly observed fate, with 25.91% of nest failures (44.70% of identified failures) attributed to tide. The most common reported causes of failure were fox depredation, crushing by people, avian predators, strong winds and nest burial, and dog depredation/disturbance. It is likely that there is a skew towards tides, predators and nest burial as the most commonly reported causes of failure because these leave traces of evidence around the nest site. It must be noted however, that prints around a nest scrape may have occurred independently of the nest loss. For example, where a predator has taken a nest, this could be a result of human disturbance.

Use of remote cameras provides more direct and compelling evidence of nest failure, and Mead (2012) revealed that of the 64 clutches monitored by cameras, nests were predominately depredated by foxes (26%, n=10), ravens (24%, n=9) and magpies (16%, n=6). Tidal inundation was responsible for 18% of nest losses. Failure of eggs to hatch due to abandonment, roll out during a storm event, crushing by human, and depredation by swamp harrier, nankeen kestrel and water rat each contributed to one clutch failure respectively (2.6%, n = 1).

Nest fates detected by remote cameras differed from observer based data (Table 8), and while cameras are likely to produce more conclusive results, they point directly at the nest and have a limited field of view and so we are still unable to assign failures to human disturbance. The best data on disturbance still remain as Weston and Elgar (2005a, 2007). The presence of a camera may furthermore alter nest fate by influencing human behaviour. For example, there were multiple cases of cameras being detected by passersby which may enable them to detect and avoid stepping on the nest (R. Mead pers. comm.).

Chick fates remain largely unknown and most evidence for loss of chicks is circumstantial. The likelihood of observing chick mortality is very low but has occurred over the years. This has included depredation by silver gull (Burke *et al.* 2004), nankeen kestrel (Weston 1998; Duivenvoorden 2007), domestic dog (Ehmke 2012), magpie (Mead 2012) and newly hatched chicks crushed in the nest by a walker (Mead 2012).

Table 8. The causes of failure attributed to Hooded Plover nests by observers over five breeding seasons. Percentage of failures is the number of nests lost as a proportion of total nests that failed (n= 521), and percentage of identified failures is the number of nests lost as a proportion of known/observed fates (n = 302).

CAUSE OF FAILURE	% OF FAILURES	% OF IDENTIFIED FAILURES
Unknown	42.03%	
Tide	25.91%	44.70%
Fox	6.91%	11.92%
Person	5.95%	10.26%
avian predator	4.22%	7.28%
strong winds/buried	4.03%	6.95%
Dog	3.26%	5.63%
predator - unidentified	3.07%	5.30%
Abandoned	1.73%	2.98%
horse	0.77%	1.32%
raven	0.38%	0.66%
vehicle	0.38%	0.66%
rain/storm washout	0.38%	0.66%
cat	0.19%	0.33%
gull	0.19%	0.33%
heat	0.19%	0.33%
magpie	0.19%	0.33%
roll out	0.19%	0.33%

Breeding success rates on Parks Victoria managed land

The above regional comparisons and nest fate summaries include Parks Victoria and non-Parks Victoria managed land. Table 9 distinguishes between the productivity of pairs monitored by BirdLife staff and volunteers on Parks Victoria and non-Parks Victoria managed land.

It would be expected that pairs occurring within the Parks Victoria estate should have a higher level of protection afforded by land reservation status than those falling outside these boundaries, and thus greater breeding output. However, in three of five breeding seasons this was not the case and the fledglings per pair, a standardized measure of success, was lower than that for pairs on non-Parks Victoria land (Table 9). This flags concern due to the disproportionately higher number of Hooded Plover locations occurring on Parks Victoria land, and leads us to further explore the spatial variation in productivity and threats across Parks Victoria land.

Across Parks Victoria managed land, 58% of breeding locations[1] (of a total of 240 locations) have been monitored over at least one breeding season from 2006/07 to 2010/11 (Appendix 2). Appendix 3 provides maps of locations of nests that have failed, hatched and fledged across Victoria. Of the 139 locations on the Parks Victoria estate where we have monitoring data, 42% have had pairs successfully breed and fledge at least one chick (Appendix 2).

If the number of successful breeding sites is tallied according to park (Appendix 4), then it becomes evident that some parks are accounting for a greater input into the overall productivity of the Victorian population. However, this is not directly proportional to the size of the park and density of breeding pairs within. Bunurong Coastal Reserve and Marlo Coastal Reserve have few breeding pairs but success from at least 67 to 75% of breeding locations. The two most densely populated parks, Belfast Coastal Reserve and Mornington Peninsula National Park, have had successful fledging events from only 44% and 50% of breeding locations over five breeding seasons respectively. This indicates that approximately half of the breeding sites in these two parks are currently acting as breeding 'sinks'.

When Appendix 5 (a series of maps showing the locations where there have been fledglings on Parks Victoria managed land over five seasons) is examined, it becomes clear that the spatial spread of successful and unsuccessful sites within parks does not appear to be random. In other words, there appear to be 'productive' stretches of coast and 'non-productive' stretches of coast. We know that this is not explained by differences in physical habitat across the areas (Ehmke *et al.* in prep.), but instead suggests that threats may be spatially clustered.

The most stark patterns are evident within Belfast Coastal Reserve (Figure 9), the Mornington Peninsula National Park (Figure 10), and Kilcunda – Harmers Haven Coastal Reserve (Figure 11). On the Mornington Peninsula, there are nodes of success, predominantly along Boags to Gunnamatta and a section of Portsea beach. The areas in the middle of the park have high rates of breeding failure. This is further discussed in Chapter 3, where breeding success spatial patterns appear most closely matched to the spatial distribution of frequency of occurrence of dogs off leash (see page 81).

[1] Note we use the terminology breeding locations here rather than pairs because pairs can move locations over time and the unit of focus is the site and the threats experienced at those sites.

Table 9. The productivity of Hooded Plover pairs monitored by BirdLife Australia's Beach-nesting Birds Program across five breeding seasons, according to whether the pairs were on Parks Victoria (PV) managed land or non-Parks Victoria managed land (i.e. managed by various local councils, Committees of Management and the Department of Sustainability and Environment). The number of pairs monitored refers to pairs regularly observed over the course of a breeding season; number of pairs successfully fledging chicks refers to those pairs that produced chicks of flying age; number of fledglings is the total number of fledglings produced by those pairs in that season, and; the fledglings/pair value reflects the number of fledglings standardized by the number of pairs monitored.

Breeding Season	**2006/07**		**2007/08**		**2008/09**		**2009/10**		**2010/11**	
Land Manager	*Non PV Land*	*PV Land*	*Non PV Land*	*PV Land*	*Non PV Land*	*PV Land*	*Non PV Land*	*PV Land*	*Non PV Land*	*PV Land*
# pairs monitored	25 (27.78%)	65 (72.22%)	19 (22.09%)	67 (77.91%)	21 (26.58%)	58 (73.42%)	30 (26.79%)	82 (73.21%)	45 (38.46%)	72 (61.54%)
# pairs successfully fledging chicks	7	19	9	17	9	13	15	24	6	20
# fledglings	9 (23.1%)	30 (76.9%)	11 (30.6%)	25 (69.4%)	14 (46.7%)	16 (53.3%)	26 (36.6%)	45 (63.4%)	9 (23.7%)	29 (76.3%)
fledglings/pair	0.36	0.46	0.58	0.37	0.67	0.28	0.87	0.55	0.20	0.40

Figure 9. The distribution of successful (fledging chicks in at least one season) and unsuccessful sites (no fledglings over five seasons), across the Belfast Coastal Reserve. Note the clustering of red and green locations, suggesting that threatening processes are spatially clustered along this coastline.

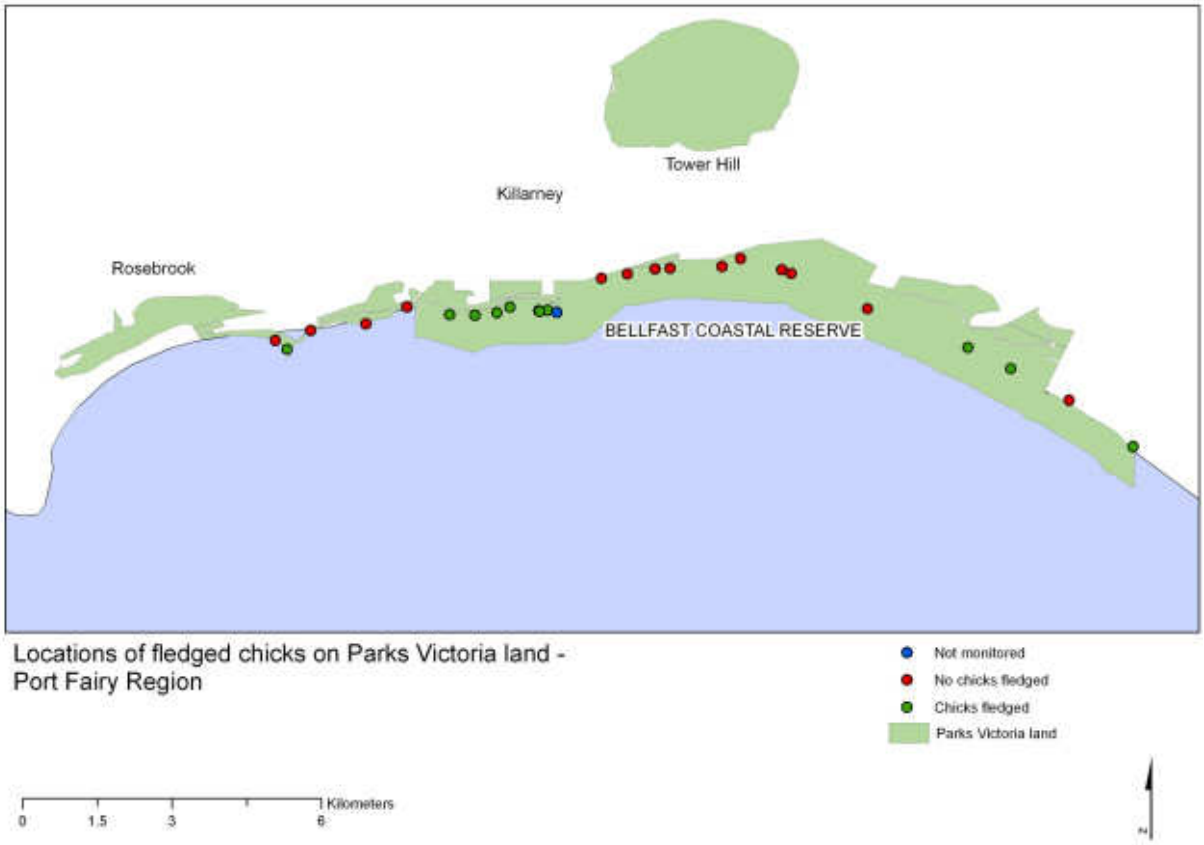
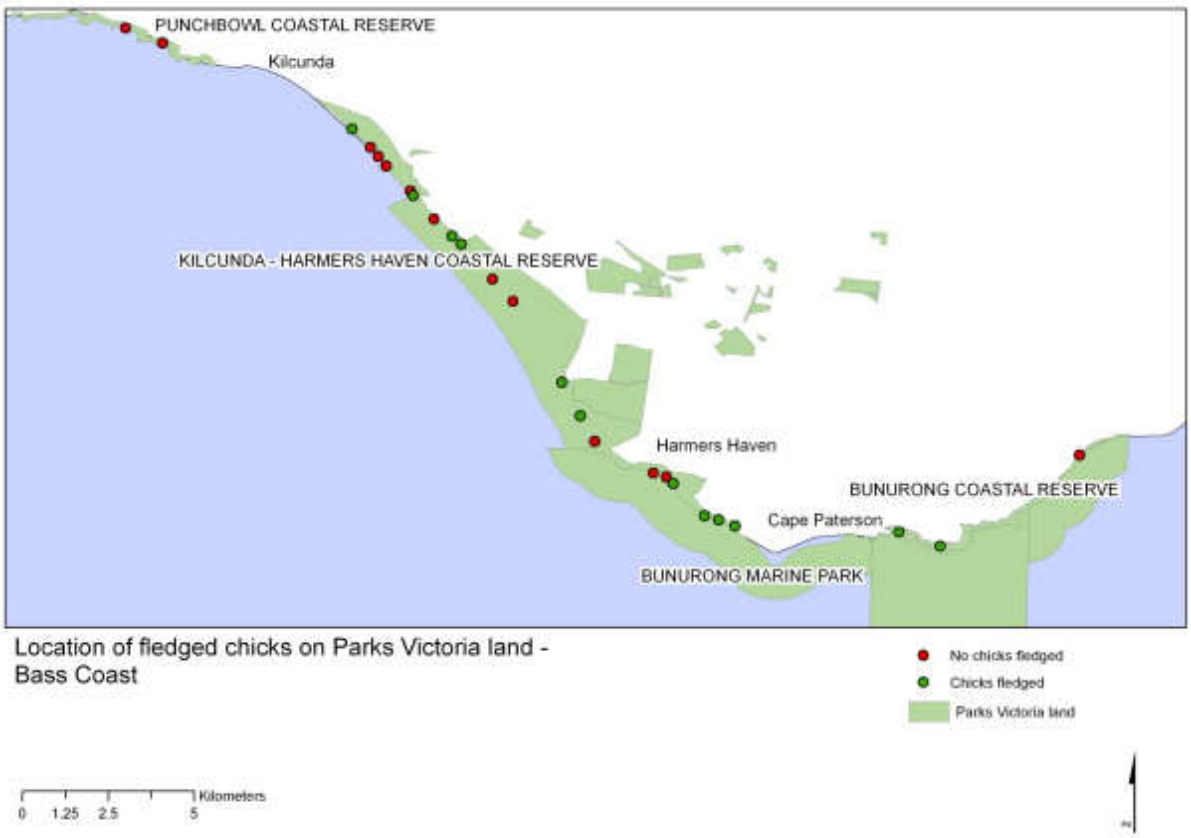


Figure 10. The distribution of successful (chicks fledged in at least one season) and unsuccessful sites (no fledglings in five seasons), on the Mornington Peninsula. Note the cluster of green locations in the southern end of the park and small clusters in the northern end. Red locations are clustered centrally around Koonya, Rye and St Andrews.

Figure 11. The distribution of successful (chicks fledged in at least one season) and unsuccessful sites (no fledglings in five seasons) along the Bass Coast. Note small clusters of red and green locations suggesting threatening processes are also clustered spatially.



Chapter 3 – Threats to Hooded Plovers

This chapter explores the range of human-related and natural threats to Hooded Plovers, mainly operating during the breeding phase. Each threat and its impact are discussed. The spatial distribution and frequency of occurrence of threats are explored on a park by park basis, as well as for individual sites monitored over five breeding seasons.

A comprehensive review of threats and the way these impact Hooded Plovers can be found in Maguire (2008). Threats primarily operate at the breeding stage by causing failure of recruitment. Table 10 provides a summary of the way each threat operates (directly, indirectly) and on what life stage (habitat, adult survival, reproductive success). Table 10 also rates the severity of each threat, based on the extent to which the threats impact breeding success and survival, independent of their spatial (along the Victorian coast) and temporal (in the context of the next 5 years) distribution. These threats are also discussed in more detail below and the exhaustive reference list as per Maguire (2008) is reduced to a few key references.

Threats appear in order of relative impact, however, it should be noted that mitigation of one threat type needs to take into account that another threat type may then become prevalent at that site and need to be addressed. These threat types are often closely linked and act in combination with one another. This again highlights the value of monitoring and feeding back monitoring results in a timely manner into conservation management decision making.

Table 10. Summary of threats to Hooded Plovers, grouped as human-related threats and natural threats. Threats appear in order of impact. The impact of each is categorized as direct or indirect, and the life stage at which the threat operates is specified. The severity of impacts is rated as high, moderate or low, and further rated with a number from 1 (lowest) to 6 (highest). The spatial distribution, across the Victorian coastline, and the temporal distribution, over the next five years, is also included.

SOURCE OF THREAT	**IMPACT (D= DIRECT, I=INDIRECT)**	**LIFE STAGE (H=HABITAT, S= ADULT SURVIVAL, R=REPRO. SUCCESS)**	**SEVERITY (RATING)**	**SPATIAL DISTRIBUTION**	**TEMPORAL DISTRIBUTION**
Human-related threats					
Coastal development	Loss or modification of habitat (i); increases in predator numbers or predator use of habitat (i); increases in recreational pressure (i)	H, R	High (6)	Widespread	Constant
Oil spills	Oiling and death of chicks and adults (d); consumption of contaminated food items (d); reduction in food items (i); beach cleaning impacts of crushing/disturbing eggs/chicks (d, i)	S, R, H	High (6)	Highly localised	Stochastic
Vehicles on beaches – illegal access	Crushing of eggs or chicks (d); collisions with and death of adults and juveniles (d); disturbance (i); modification of habitat (i)	R, S, H	High (5)	Highly localised	Seasonal peaks
Weed: Marram Grass	Loss or modification of habitat (i)	H	High (5)	Widespread	Constant
Beach cleaning and kelp harvesting	Crushing of eggs or chicks (d); collisions with and death of adults (d); disturbance (i); loss or modification of habitat (i)	H, R, S	High (5)	Absent (PV beaches)	Absent (PV beaches)
Dogs off lead	Crushing of eggs or chicks (d); depredation of eggs or chicks (d); disturbance (i)	R	High (4)	Widespread	Constant
Introduced Foxes	Depredation of eggs, chicks or adults (d)	R, S	High (4)	Widespread	Constant
Recreationists – static activities (e.g. fishing)	Crushing of eggs or chicks (d); disturbance (i)	R	High (4)	Widespread	Constant, seasonal peaks
Superabundant native predators: Ravens	Depredation of eggs or chicks (d)	R	High (4)	Widespread	Constant

SOURCE OF THREAT	IMPACT (D= DIRECT, I=INDIRECT)	LIFE STAGE (H=HABITAT, S= ADULT SURVIVAL, R=REPRO. SUCCESS)	SEVERITY (RATING)	SPATIAL DISTRIBUTION	TEMPORAL DISTRIBUTION
Horses	Crushing of eggs or chicks (d); collisions with and death of adults and juveniles (d); disturbance (i); modification of habitat (i)	R, H, S	High (4)	Localised	Constant
Stock (cattle, sheep, goats, camels)	Crushing of eggs or chicks (d); modification of habitat (i)	R, H	High (4)	Absent (PV beaches)	Absent (PV beaches)
Feral deer	Crushing of eggs or chicks (d); modification of habitat (i)	R, H	High (4)	Highly localised	Constant
Cats (feral and domestic)	Depredation of eggs, chicks or adults (d)	R, S	High (4)	Localised	Constant
Vehicles on beaches – SLSCs	Crushing of eggs or chicks (d); collisions with and death of adults and juveniles (d); disturbance (i)	R, S	High (4)	Localised	Constant, seasonal peaks
Weed: Sea Spurge	Loss or modification of habitat (i); increased likelihood of nest depredation (i)	H	High (4)	Localised	Constant
Weed: Sea wheat-grass	Loss or modification of habitat (i); increased likelihood of nest depredation (i)	H	High (4)	Localised	Constant
Dune stabilization works	Loss or modification of habitat (i)	H	High (4)	Highly localised	Constant
Recreationists – Mobile activities (e.g. walking)	Crushing of eggs or chicks (d); disturbance (i); modification of habitat (i)	R, H	High (3)	Widespread	Constant, seasonal peaks
Dogs on lead	Crushing of eggs or chicks (d); disturbance (i)	R	High (3)	Widespread	Constant
Superabundant native predators: Silver gulls	Depredation of eggs or chicks (d)	R	High (3)	Widespread	Constant

SOURCE OF THREAT	IMPACT (D= DIRECT, I=INDIRECT)	LIFE STAGE (H=HABITAT, S= ADULT SURVIVAL, R=REPRO. SUCCESS)	SEVERITY (RATING)	SPATIAL DISTRIBUTION	TEMPORAL DISTRIBUTION
Superabundant native predators: Magpies	Depredation of eggs or chicks (d)	R	High (3)	Localised	Constant
Litter including fishing line	Entanglement and death of chicks or breeding adults (d); increases in predator numbers or predator use of habitat (i); disturbance to incubating adults (i)	S, R	High (3)	Localised	Constant, seasonal peaks
Driftwood removal	Crushing of eggs or chicks (d); disturbance (i); loss or modification of habitat (i)	H, R	High (3)	Localised	Occasional
Introduced rodents	Depredation of eggs and newly-hatched chicks (d)	R	Moderate (2)	Highly localised	Constant
Vehicles on beaches – land manager access	Crushing of eggs or chicks (d); collisions with and death of adults and juveniles (d); disturbance (i)	R, S	Low * (1)	Localised	Constant
Vehicles (air)	Disturbance (i)	R	Low (1)	Localised	Constant
Vehicles (water)	Disturbance (i)	R	Low (1)	Localised to launching sites	Constant
Natural threats					
High tides	Washing out eggs (d); drowning chicks (d); modification of habitat (i)	R, H	High (4)	Widespread	Cyclic, often influenced by storm surges (see below)
Storms and extreme weather	Washing out or burying eggs (d); egg/chick exposure (i)	R, H	High (4)	Widespread	Variable, often seasonally related
Avian predators: Ravens	Depredation of eggs or chicks (d)	R	High (4)	Widespread	Constant
Avian predators: Birds of Prey	Depredation of chicks or adults (d)	R, S	Moderate (4)	Widespread	Constant
Avian predators: Magpies	Depredation of eggs or chicks (d)	R	Moderate (2)	Localised	Constant
Avian predators: Gulls	Depredation of eggs or chicks (d)	R	Moderate (2)	Widespread	Constant

Source of threat	Impact (d= direct, i=indirect)	LIFE STAGE (H=HABITAT, s= ADULT SURVIVAL, R=REPRO. SUCCESS)	Severity (RATING)	spatial distribution	temporal distribution
Avian predators: Other	Depredation of eggs (d); crushing of eggs (e.g. Emus) (d)	R	Low (1)	Localised	Constant
Native rodents	Depredation of eggs (d)	R	Low (1)	Highly localised	Constant
Reptilian predators	Depredation of eggs or chicks (d)	R	Low (1)	Highly localised	Seasonal peaks

Human-related threats

Coastal development

While development of the coast within the Parks Victoria managed estate is subject to high levels of control, development of nearby coastal towns and areas adjacent to the park boundaries have major implications for the birds within the Parks Victoria estate. The threatened status of Hooded Plovers under State Legislation in Victoria should trigger consideration of the impacts to this species by coastal planners, however, impacts are often underestimated due to the dispersed spread of the Hooded Plover population (the scenario of 'death by a thousand cuts').

Across Victoria, Hooded Plovers occur on average within 950 m of a beach access point (Birds Australia Hooded Plover count 2006). This is largely due to development of coastal towns and the areas adjacent to the coastline across most of Victoria. While species such as Hooded Plovers may persist in heavily developed or recreated areas, it is in these areas where breeding success is lowest and sites can become 'population sinks'. Pairs adjacent to residential areas and coastal townships are subject to high rates of disturbance and increased probabilities of egg and chick crushing.

Coastal development results in modification and loss of habitat which has flow on effects at the population level and also at the individual level, impacting adult survival and reproductive success. Coastal infrastructure in the primary dune limits available nesting habitat and resilience to climate change, as there is little room for inland retreat. Formalising access points increases use of habitat by recreationists, while lack of access, when new developments arise adjacent to dune systems, can lead to creation of informal access points by residents (see case study on page 162), trampling of habitat (and nests and chicks in situ) and can prompt erosion control measures which can further reduce habitat availability (see page 65). Domestic animals (cats and/or dogs) associated with residential developments can increase the predation pressures on nearby nesting sites.

Armouring the coast by creating sea walls, placing rocks on the beach, dune matting and brush matting to protect coastal infrastructure and assets, has the potential to radically alter beaches and habitat availability for Hooded Plovers. Natural dune mobility and sand replenishment processes are radically impacted by sea walls and groins and this will have implications for the amount of habitat available. Even small scale changes to habitat via erosion works such as brush matting of dunes and infrastructure protection from rising sea levels, such as placement of boulders along the base of the dune to protect shacks on South Australian beaches, have resulted in loss of territories (Maguire 2008).

Coastal development varies along the Victorian coast and is most highly concentrated along the central Victorian coastline. The westernmost (west of Portland to the SA border) and easternmost (east of Lake Tyers to the NSW border) extremes are the two most undeveloped sections of the Victorian coast and this is largely due to the presence and expanse of two major parks: Discovery Bay Coastal Park and Croajingalong National

Park, respectively. Each of these parks have limited access, making many Hooded Plover sites remote and difficult to access.

Oil spills

Oil spills are stochastic (of an unpredictable nature) events that have the potential to impact Hooded Plovers by directly oiling birds, removing foraging substrates and resources, and disturbing the ecosystem processes that are necessary for these beach systems to function (Weston 2003). Ingestion of oil and oiling of plumage can cause death of adults/chicks, and oiling of eggs (directly or via the adult's plumage) can result in failure to hatch.

While the impacts of an oil spill are very highly rated, the likelihood of an oil spill is considered relatively low compared to other threats. The most recent major oil spill impacting the birds along the South Gippsland coast (Kilcunda coastal reserve and Phillip Island) was in 2001. This was the largest oil spill event to impact wildlife in Victoria's history, with 453 seabirds affected (DSE 2013).

Vehicles – illegal and legal access

Vehicle use of coastal environments has multiple impacts on the birds, but most severe is that this threat can impact survival of adults. Vehicles on beaches include 4-wheel drives (4WDs), trail bikes, quad bikes, kite cars, horse drawn carts and sulkies, as well as management, research and Surf Life Saving Club (SLSC) vehicles.

We consider three degrees of access: illegal users (recreational access); Surf Life Saving Club (SLSC) vehicles, and management access (land managers, researchers and contractors). These are considered separately based on differences in management to overcome impacts. Land managers are the group where impacts are most easily conveyed and mitigated; SLSCs are considered separately as there is a broader range of drivers accessing beaches and emergency access overrides protocols for mitigating threats to birds, and; illegal users represent the most difficult group to identify and manage.

Direct impacts include collisions between birds and vehicles. In poor visibility conditions such as low lighting, night driving and inclement weather, risks of striking birds are greatly enhanced (Weston 2003). In the latter conditions, this impact can be similar for vehicle users both illegally and legally accessing the beach, but in the latter case, informed drivers are more likely to adhere to slower speed limits and avoid accessing the beach in these conditions.

Vehicles have a higher likelihood of crushing a nest when driven above the high tide mark, relative to a walker, as the wheel base covers a greater area of beach. In the Coorong, South Australia, 81 % of experimentally deployed nests on beaches were crushed by 4WDs within a typical month long incubation period (Buick and Paton 1989). In western Victoria, illegally driven vehicles (trail bikes) crushed 18 % of Hooded Plover nests (Weston and Morrow 2000). Buick and Paton (1989) also report that Hooded Plover chicks shelter in wheel ruts and this probably accounts for the high rate of chick crushing by vehicles on the Coorong (30 % of chick mortalities). Dodge (2003) revealed that Surf Life Saving Club patrol vehicles crushed 8 % of experimentally deployed beach-located nests on the central Victorian coast, indicating that legal vehicles also have an impact. In the Mornington Peninsula National Park, a fox contractor ran over 3 active Hooded Plover nests on one beach run due to driving above the high-tide mark, which also indicates that in the absence of education and vehicle protocols, management vehicles can also have significant impacts.

There are also numerous indirect impacts, largely related to habitat changes and avoidance by birds of beaches heavily used by vehicles (Stephens 2004; Dennis and Masters 2006). Off-road vehicles can be highly destructive to the environment by causing severe sediment disruption and erosion (Anders and Leatherman 1987; Priskin 2003; Schlacher and Thompson 2008), destruction of dune vegetation (Luckenbach and Bury 1983; Rickard *et al.* 1994) and reducing the diversity and abundance of the invertebrate (macrobenthic) fauna (i.e. food availability, Schlacher *et al.* 2008).

Illegal vehicle access is more prevalent along the coast between Warrnambool and Portland, where there are many entry points to the coast and a small human population, and hence a lower likelihood of detection and greater difficulty in enforcement. Proximity to the South Australian coast where beach driving is legal is also thought to intensify the issue of illegal vehicle access.

Legal access occurs across the Victorian coast and occurs at low frequencies. Surf life saving vehicles occur in a seasonal peak related to the life saving patrol season, typically December school holidays, then winding down with patrols on holiday weekends up to Easter.

Weeds – Marram Grass, Sea Spurge, Sea Wheat-grass

Weeds, such as Marram Grass (*Ammophila arenaria*; deliberately introduced from Europe for dune stabilization purposes), Sea Spurge (*Euphorbia paralias;* originating from Europe and presumably introduced in shipping ballast water), and Sea Wheat-grass (*Thinopyrum junceiforme;* native to Europe and deliberately introduced for dune stabilization purposes), have been identified as key species that change the structure of beach and foredune habitats (Cousens *et al.* 2013). These structural changes in turn alter the resources available (foraging, nesting etc) to Hooded Plovers, leading to either direct impacts (increased predation, mortality or abandonment of beaches) to more

indirect impacts such as reduced breeding success in sub-optimal habitat. For example, Mead (2012) found that of the 18% of nests across Victoria lost to tide, most of these were in far west Victoria. This is in line with Cousens *et al.* (2013) reporting that the most extensive Marram grass infestations occur in Victoria, where the dune is completely unavailable as nesting habitat.

Marram grass is rated as being of greater threat to the Hooded Plover than sea spurge and sea wheat-grass due to Hooded Plovers showing strong avoidance of Marram vegetated dunes, whilst at low to moderate densities of sea spurge and sea wheat-grass infestation, Hooded Plovers still place their nests amongst these weeds in the foredune and dune.

Weed infestations vary in extent and species dominance along the Victorian coast. Far western Victoria is dominated by Marram Grass; Sea Wheat Grass occurs commonly within the Mornington Peninsula National Park; Sea Spurge is absent (with the exception of small outbreaks that are rapidly removed) in the Mornington Peninsula National Park and in heavy abundance along the south Gippsland coast.

Beach cleaning and kelp harvesting

Beach grooming, beach replenishment, and the harvesting of kelp (seaweed) from beaches alters the habitat of the species directly by removing the natural wrackline (area of beach containing seaweed and other natural wave-cast organic debris) feeding habitat, reducing the availability of invertebrate prey (as they get removed with the kelp), altering beach topography, removing shelter/cover and preventing the establishment of native beach vegetation (Schulz 1992a; Parks Victoria 1998; Weston and Morrow 2000; Weston 2003; U.S. Fish and Wildlife Service 2007). This can therefore reduce areas of occupancy for the species.

There are also impacts to the breeding success of birds when these activities result in considerable disturbance to the birds (e.g. presence of kelp harvesters on beaches for prolonged periods of time; noise and presence of tractors on beach) or direct crushing of nests (e.g. beach grooming).

Beach grooming is commonly associated with town beaches along the Victorian coast and there is no knowledge of this occurring on Parks Victoria managed beaches. Kelp harvesting occurs in Tasmania but there is no knowledge of this occurring on the Victorian coast.

Dogs on beaches – dogs off and on lead

In November 2012, 155 satellite trackers were placed on dog collars ('igotu' loggers) in a voluntary participation project comparing the movement of dogs in on-leash and off-leash areas along the Bellarine Peninsula and Surf Coast (Schneider 2013). On average dogs spend half an hour on the beach during a given walk, travel ~850 metres from an access point and in this distance, cover 2.5 kilometres of beach in their zigzag movements. On average, dogs run into the dunes from the beach 1.5 times per walk. A key finding of this study was that there was no significant difference in the space use by dogs on on-leash and off-leash beaches because on on-leash beaches the majority of dogs were off-leash (i.e. regulations were not effectively minimizing dog movements).

The greater use of the upper beach and dune means that there is a higher likelihood of dogs off lead crushing eggs and chicks and potentially depredating the eggs and chicks they encounter. Domestic dogs have been known to partially or entirely destroy shorebird nests, including those protected with symbolic fencing (e.g. Western Snowy Plover nests, cited in U.S. Fish and Wildlife Service 2007; experimental beach-located nests, Weston *et al.* 2012a; Hooded Plover nests, B. Baird pers. comm., T. Ryan pers. comm.; BirdLife Australia remote camera data 2010-2011).

The predatory impacts of domestic dogs are documented for birds worldwide, including devastating impacts on threatened species populations (Taborsky 1988; Diamond 1989; Genovesi and Duprae n.d. in Brickner 2000). Dogs have been observed eating Hooded Plover eggs (Hanisch 1998; T. Ryan pers. comm.), and eating model (quail) eggs from artificial nests mimicking Hooded Plover nests on beaches (Stojanovic unpublished data 2007; Weston *et al.* 2012a; Cribbin 2012).

While records of chick fates are rare (as observers are rarely present when the chicks die), there is one record of a 4.5 week old chick that was a less than a week from flying age being mauled and killed by an off leash labrador (Ehmke 2012). This was within a well-signed area requesting dogs to be leashed at Point King beach, Portsea, Victoria. On Portsea back beach, within the Mornington Peninsula National Park, remote video surveillance of a chick area captured footage of two off leash dogs left on the beach while the owners went swimming, chasing the adult and chick. The birds and dogs went out of frame and this was the last time the chick was observed (G. Maguire pers. obsv.). Unleashed dogs have also been observed killing Piping Plover chicks (Cairns and McLaren 1980; U.S. Fish and Wildlife Service 1996) and New Zealand Dotterel chicks (Wills *et al.* 2003).

Domestic dogs are known to chase adult beach-nesting birds (Retallick and Bolitho 1993; Weston and Morrow 2000; G. Maguire pers. obsv.; G. Ehmke pers. comm.), which can lead to prolonged absences from the nest or brood. Chasing and the unpredictable movement, proximity and speed (Burger 1986; Glover *et al.* 2011) of unrestrained dogs are traits that do not promote 'habituation', the process of wildlife learning to reduce response intensities or frequencies with increasing exposure to the stimulus (Lafferty 2001; Sastre *et al.* 2009). Rather, these attributes promote 'sensitization', or enhanced

response frequencies or intensities with increasing exposure to stimuli (Glover *et al.* 2011).

Walkers accompanied by dogs often evoke greater responses from ground-dwelling birds than people alone (Sime 1999; Lord *et al.* 2001; Taylor *et al.* 2007; Sastre *et al.* 2009). Glover *et al.* (2011) showed that of eight shorebirds tested, stimulus type (walker, jogger, walker with leashed dog) significantly influenced Flight Initiation Distance (FID) of three species (another two approached significance). Excluding joggers, all three species had the highest FID when approached by a person with a leashed dog, rather than by a walker. Lambert and Ratcliff (1979) and Taylor *et al.* (2005) suggest that it is likely that dogs are seen by ground-dwelling birds as much more of a threat than people, as dogs are more likely to catch and kill them or their chicks.

Western Snowy Plovers flushed more frequently and remained off their nests longer when a person was accompanied by a dog than when alone (Page *et al.* 1977). Adult Piping Plovers and their chicks ceased feeding 52 % of the time when dogs were within 50 m compared to 31 % when people were within the same proximity (Hoopes 1993). Hoopes (1993) also found that the response distance of Piping Plovers was greater for dogs (46 m) compared with people (23 m), and that the reacting birds moved more than double the distances and remained away from the nest longer when disturbed by dogs compared to people. Similarly, Yalden and Yalden (1990) found that breeding plovers in the United Kingdom flushed from the nest at greater distances when a walker was accompanied by a dog. Lord *et al.* (2001) studied the impact of three treatment types (walking, running or leading a dog) on northern New Zealand Dotterels and found that people who were accompanied by a dog caused the greatest level of disturbance in terms of flush distance, length of time away from the nest and distraction display intensity.

On Victorian beaches, 18-19% of encounters with Hooded Plover nests or broods (0.47 per hour) involved dogs (Weston and Elgar 2005a, 2007). The highest frequencies of Hooded Plover nest absences were in response to people accompanied by unleashed dogs (Weston and Elgar 2007). Hooded Plovers appear to respond with higher rates of nest absences in response to encounters with unleashed dogs compared to leashed dogs. Incubating Hooded Plovers left the nest in 21 % of encounters with leashed dogs, similar to that for encounters with walkers, while 38.4 % of encounters with a walker accompanied by an unleashed dog caused the incubating bird to leave the nest for as long as 30 minutes (Weston and Elgar 2007). Furthermore, unleashed dogs (with walkers) caused the brooding of chicks to cease on 51.4 % of encounters, compared with 33.3 % for leashed dogs (Weston and Elgar 2005a). This suggests that the birds differentially perceive the behaviour of dogs rather than their mere presence, and that off-leash movement is perceived as a greater threat.

Unrestrained dogs roam within coastal habitats perhaps more than any other stimulus type (except possibly raptors; Coombes *et al.* 2008). Of 380 coastal residents in south-eastern Australia, 36.8% owned a dog of which 93.6% took their dog to the beach (Maguire *et al.* 2011a). On Australian beaches (90%, Weston and Elgar 2005a; 82%,

Williams *et al.* 2009) or US beaches (93%; Lafferty 2001), the majority or at least a substantial proportion of dogs are unrestrained, and this includes areas where dogs are not permitted off-leash or at all, such as national parks (88%, 1991-98, Dowling and Weston 1999; 64%, Arnberger *et al.* 2005), recreation reserves (22%, Austria, Arnberger and Eder 2008), wetland reserves (100%; Antos *et al.* 2007) and buffers (68%, Weston *et al.* 2009). Walkers and joggers without dogs were most common on beaches in Victoria, Australia, where active Hooded Plover nests occurred (16.9% and 13.4% respectively), yet walkers and joggers accompanied by unleashed dogs occupied more levels of the beach. Thus, in at least many parts of the world, wildlife most frequently encounter free-roaming dogs regardless of prevailing local regulations (Natt and Weston 1995; Dowling and Weston 1999; Weston 2003; Lafferty *et al.* 2006; U.S. Fish and Wildlife Service 2007; Weston *et al.* 2012a).

Dodge (2003) revealed that 20 % of dog owners were non-compliant with Hooded Plover protective signage and fencing, and 99 % of this non-compliance was through not leashing their dog. In New Zealand, Bridson (2000) discovered that most people thought that dogs were a threat to breeding New Zealand Dotterels, including those that regularly walked their dogs at the beach. Between 68-78 % of respondents thought that dogs should be excluded from 'wildlife refuge' beaches, but largely because of the disruption this caused to their own recreational experience. More than 90 % of respondents believed in fining dog owners in breach of regulations, however, many thought that only owners of 'big dogs', uncontrolled dogs or those caught chasing birds should be prosecuted (Bridson 2000). In her interviews with dog owners from coastal Victoria, Henry (2006) discovered that the majority of respondents did not feel obliged to leash their dogs at the beach. This was potentially explained by conflicting values about wildlife conservation, human recreation and dog access to beaches, the commonly held belief that people's own dog(s) are less of a threat to beach-nesting birds than dogs in general, and a strong belief that unleashed exercise is beneficial for dog health (Williams *et al.* 2009). Several external barriers to compliance were identified, including the social influence of beaches generally being perceived by the broader dog-owner community as a good place for unleashed dogs, lack of provision of information about the threats that dogs pose to beach-nesting birds, lack of, or at least lack of awareness, of designated off-leash areas and lack of enforcement. Enforcement of dog regulations on beaches by the managing agencies is often lax or nonexistent (Weston 2003; U.S. Fish and Wildlife Service 2007).

Dog access to the Victorian coast and within the Parks Victoria estate is widespread. Access varies from dogs prohibited, on leash, seasonal and temporal restrictions, and off leash areas. This is often unrelated to land reservation status, as there have been exceptions to access within National Parks whereby dogs are permitted in sections of the Mornington Peninsula National Park and Great Otway National Park. Appendix 6 provides details of the dog access status for each park where Hooded Plovers occur.

Foxes

Foxes will prey directly on adults, chicks and eggs. In a study by Mead (2012) in Victoria using motion-triggered remote nest surveillance cameras, foxes accounted for 26% of 38 Hooded Plover nests with eggs that were depredated (of 64 nests that were monitored by cameras).

It is thought that 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 beach-nesting birds, such as Hooded Plovers (Weston 2003).

In NSW, foxes are the most common predator of Hooded Plover, Oystercatcher and Little Tern eggs and chicks (NSW National Parks and Wildlife Service 2006, 2007, 2008). At the Bega River mouth in NSW, a single fox was responsible for killing 30 Little Tern chicks and 14 eggs in just two days (NSW National Parks and Wildlife Service 2006). In Western Australia, the stomach contents of a single fox contained up to 30 chicks of Red-capped Plovers (R. Johnstone pers. comm.). In western Victoria, Weston and Morrow (2000) attributed 28.6 % of known Hooded Plover nest failures to fox predation, while Stojanovic (2008) found fox predation rates of experimentally deployed nests containing quail eggs to be as high as 37 % along beaches in western Victoria.

Foxes do not always detect beach-located nests and have been recorded as passing within less than a metre of Hooded Plover nests without detection (Ressom 2001; M. Quinn pers. comm.; G. Maguire pers. obsv.). Furthermore, dogs have been known to cause higher rates of flushing from birds compared with visits by foxes (Hamerstrom *et al.* 1965).

Management, such as nest cages or small fences around the nest, may enhance the detection of nests by foxes, as they have been observed circling exclosures and have been linked with the predation of Hooded Plover and Western Snowy Plover chicks and adults (NSW National Parks and Wildlife Service 2006, 2007, 2008; U.S. Fish and Wildlife Service 2007; A. Whitelaw pers. comm.).

Foxes are widespread across the Victorian coast, however, there have been major fox control projects such as Southern Ark (covering 800,000 ha of public land in East Gippsland) and Glenelg Ark (covering 90,000 hectares of State forest and National Park in south-western Victoria) which have been highly successful at greatly reducing fox predation pressure in coastal habitats. There have also been smaller targeted fox control projects occurring in coastal areas, such as fox baiting in the Mornington Peninsula and Wilsons Promontory National Parks, and soft-jaw trapping at Cape Liptrap Coastal Park.

Recreationists – static and mobile

Recreational use of beaches reaches a peak in the warmer months of spring and summer and this overlaps with the breeding period of Hooded Plovers.

Mobile recreationists predominantly use the wet, hard sand as it is easier to walk/jog on, and thus the majority of mobile people are unlikely to crush nests. However, for people moving above the high-tide mark (particularly when using the beach at times of high tide) or through the dunes, the chances of crushing eggs or chicks are high. In Mornington Peninsula National Park, Victoria, 30 % of Hooded Plover nests were crushed by people prior to implementation of management actions, and this occurred in both beach (51 %) and dune (21 %) habitats (Dowling and Weston 1999). Hooded Plovers often nested near to informal dune tracks, presumably due to the openness of the area, and thus were vulnerable to crushing (Dowling and Weston 1999). Dodge (2003) showed that most artificial beach-located nests were crushed by mobile people (64 %), however, she also indicated that mobile people exhibited the highest rate of compliance with protective signage and fencing, thus showing high potential for this threat to be reduced.

Weston *et al.* (2012b) reviewed Flight Initiation Distances (FID) for 250 Australian birds and found that the Hooded Plover had the highest positive residual value in a linear regression of FID on mean body mass. In other words, the Hooded Plover showed the highest response to a human approach of any species in its size class, and thus appears to be one of Australia's most sensitive species to human disturbance.

In terms of disturbance, Weston and Elgar (2007) revealed that incubating Hooded Plovers experienced mobile people more frequently than any other user group, and that walkers (unaccompanied by dogs) were responsible for more time off the nest in total (33.1%) than any other source of disturbance, related to frequency of encounter. However, Weston *et al.* (2011) distinguished between the severity of the impact of mobile and static (e.g. fishing, sunbaking, picnicking) disturbance, and found that static people caused substantial disruption to incubation that almost always exceeded one hour, while generally the birds returned to the nest within an hour when encountering mobile people (9.5% versus 85.7% return rate within an hour for static versus mobile encounters).

Disturbance of incubating birds results in the birds coming off the nest and distancing themselves from the eggs so that camouflage takes effect. This can result in eggs being exposed to lethal thermal extremes (e.g. on days above 30° C the embryo can die within half an hour or less; Weston and Elgar 2007; Maguire 2008). Chicks in their first two weeks are also vulnerable to thermal exposure as they require regular brooding by the adult birds (Weston and Elgar 2005a). Disturbance can also be lethal to chicks via energetic stress and dehydration, where lengthy periods in hiding lead to starvation and frequent reactions to disturbance deplete energy reserves (Weston and Elgar 2005a). The eggs and chicks are also more susceptible to depredation in the absence of the adult birds.

Human recreational use of beaches is common across the entire Victorian coast. There is variation in the intensity of this use and the types of recreational activities undertaken across given beaches (refer to Table 15).

Superabundant native predators – Ravens, Silver Gulls and Magpies

Superabundant native predators such as ravens, magpies and gulls, pose a major predatory threat to the eggs and chicks of Hooded Plovers. Gull populations have undoubtedly increased since European settlement (Blakers *et al.* 1984). Raven (Forest Ravens *Corvus tasmanicus*, Australian Ravens *C. coronoides*, Little Ravens *C. mellori*) populations are thought to have increased since European settlement (Blakers *et al.* 1984; Schulz and Bamford 1987; Schulz 1992a). Increases in food resources, such as coastal tips and urban rubbish bins, may sustain artificially high populations, and ravens are attracted to the dunes when coastal shrubs are fruiting (Weston and Morrow 2000). Australian Magpies (*Cracticus tibicen*) are often fed by residents in backyards. Mead (2012) used motion triggered remote nest surveillance cameras at 64 nests and identified ravens and magpies as major Hooded Plover egg predators, accounting for 24% and 16% of nest failures, respectively. Ravens are also known to have hunted and killed flying Hooded Plovers (Weston 2000, 2003). Duivenvoorden (2007) found that Hooded Plover chicks were frequently disturbed by approaching ravens and were more responsive to ravens than to gulls. The reaction of chicks was commonly to crouch on the spot. In one observation, a flock of 20 ravens flying vocally overhead caused chicks to run and hide within an artificial teepee shelter and they did not emerge until the ravens had left the area. Weston and Elgar (2005a) found that 77% of Hooded Plover encounters with ravens resulted in interruptions to brooding (for up to a maximum of 19 minutes), and interruptions to chick foraging in 43% of encounters.

Silver Gulls (*Larus novaehollandiae*) predated 19% of experimentally deployed nests of quail eggs along beaches in Western Victoria (Stojanovic 2008). Silver Gulls have also been observed attacking and predating a two-day old Hooded Plover chick (Burke *et al.* 2004). Generally, beach-nesting birds are effective at defending their eggs and chicks against gulls (Weston 2000). However, it appears that gulls are able to approach nests more closely when the attending adults are disturbed away from the nest, which may suggest gull predation is more likely in highly disturbed areas (Weston 2000).

Signing and fencing of nesting areas on the beach and dunes may provide perches for avian predators (Hallett *et al.* 1995; Weston 2003; NSW National Parks and Wildlife Service 2007). Although signs and fences are important conservation tools in many areas, land managers need to be aware that modifications to them may be necessary to deter predators in some circumstances.

These predators are more highly rated as a threat when they are at elevated population levels (human-related threat) than when at natural levels (natural threat) where lower

rates of encounter between Hooded Plover nests/chicks would be expected due to lower numbers of these predators using beaches.

Horses

Horses ridden on beaches and dunes can have major impacts on the breeding success of beach-nesting birds. While most equestrian use of beaches occurs on the wet sand, during high tide periods, horse riders are forced to ride above the high-tide mark. Horses can crush nests if ridden above the high-tide mark or in the dunes (horses ridden along the base of the foredune have been observed to crush Hooded Plover nests in western Victoria, G. Maguire pers. obsv.) Horses can crush chicks, particularly if ridden swiftly along the beach, as chicks cannot move as quickly out of their path, and they could potentially collide with and injure or kill adults. Excessive disturbance by horse riders can also contribute to nest failure through exposure of eggs and chicks to thermal extremes, predators and energetic stress. Horses, being large, hoofed animals, also have an impact on the physical environment. If ridden in the dunes, they contribute to heavy erosion, and when ridden on the soft sand of the beach, leave craters that make chick navigation across the beach difficult. On horse beaches between Warrnambool and Narrawong VIC, only 7% of eggs have fledged chicks successfully (7 chicks from 96 eggs, 12 pairs). This is almost half that of horse-free beaches in this same section of coast (13 chicks from 99 eggs, 9 pairs; BirdLife Australia data).

Horse riding is only permitted on certain beaches in Victoria and so is a more localised threat. There is high variability in the regulations and permit systems for horse riding across the Parks Victoria estate. Horse riding is most prevalent along the coast between Warrnambool and Portland where it is unregulated with the exception of commercial operators. Horse riding also occurs in a section of the Mornington Peninsula National Park (St Andrews beach) by a commercial operator as well as private recreational users; in Kilcunda-Harmers Haven coastal reserve under a strict permit system for recreational users; and within defined areas of the Great Otway National Park and Cape Liptrap Coastal Park (between the ocean outfall pipeline and Arch Rock).

Stock (cattle, sheep, goats)

Stock on beaches have direct impacts on nesting birds resulting in the trampling or burying of nests (by shifting sand when moving through dunes), and indirect impacts via disturbance of incubation, and erosion of dune and beach habitats.

Stock are no longer considered an active threat in Victoria as they have been actively managed via permanent dune fencing (Baird and Dann 2003; Weston 2003). There is potential over time for fences to degrade and for stock to access beaches if these fences

are not repaired, but the occurrence of stock in the coastal hinterland is uncommon across the Parks Victoria estate.

Feral deer

Feral deer have a similar impact as stock on beaches, with direct risks of trampling nests and indirect impacts via disturbance of incubation, and erosion of dune and beach habitats.

Feral deer are most common along the East Gippsland coast where their prints are frequently seen on the foredune and beach above the high-tide mark (L. Axen pers. comm.; T. Mitchell pers. comm.).

Cats (feral and domestic)

Cats are opportunistic predators and will eat a wide variety of foods including birds (Seebeck and Clunie 1997; Urquhart and Teoh 2001). Video monitoring of nests of three species of ground-nesting birds (Banded Dotterel *Charadrius bicinctus*, Black Stilt *Himantopus novaezelandiae* and Black-fronted Tern *Sterna albostriata*) in New Zealand revealed that cats were responsible for 43 % of predation of eggs and were the only mammal responsible for death of chicks and adults (Sanders and Maloney 2002). In New Zealand, cats are identified as major predators of New Zealand Dotterel, Shore Plovers (*Thinornis novaeseelandiae*) and Chatham Island Oystercatchers (*Haematopus chathamensis*) and have contributed to local extinctions and species declines (Dowding 1997; DOC 2001; Dowding and Murphy 2001; Harper 2002; Moore *et al.* 2001; Dowding and Davis 2007). On Matakana Island in New Zealand, cats accounted for 11 % of New Zealand Dotterel nest failures (Wills *et al.* 2003). In the USA, cats have also been identified as predators of Western Snowy Plover adults and eggs (Page 1988; U.S. Fish and Wildlife Service 2007). In Australia, Marchant and Higgins (1993) list cats as a threat to Beach Stone-Curlew, and cats have depredated Hooded Plover nests in Tasmania (Hanisch 1998) and been suspected predators of Hooded Plover adults at some caged nest sites at Phillip Island Nature Park (B. Baird pers. comm.).

Evidence of cats (e.g. prints) on beaches is rare in Victoria. This may be a product of low detection rates. There have been several studies using remote cameras on the Victorian coast on Hooded Plover territories and cats have been detected in only 1.2% of sites (in Discovery Bay National Park), and in no instance did they depredate real or artificial Hooded Plover nests (n= 161; Stojanovic 2009; Mead 2012; Cribbin 2012).

Scoutguard images, left: cat passing by an artificial nest site placed in the dune; right: a magpie depredating chicks in a recently hatched nest.

Dune stabilization works

Measures to stabilize dunes and control erosion are one of the main sources of habitat modification that impacts beach-nesting birds. The main methods of dune stabilisation used in Australia are brush matting (laying dense mats of dry, cut brush over bare patches of sand) or planting dune-stabilising grasses, such as the introduced Marram Grass (which was still being recommended into the 1990s, e.g. Kesby and Druett 1997) or the native Hairy Spinifex (Weston 2003).

Introduced grasses are no longer planted on the Victorian coast, but the legacy of previous plantings are dense stands of these weeds in dune systems, particularly along the south west Victorian coast. The impacts of these weeds are discussed above.

Brush matting limits nesting habitat availability for beach-nesting birds, as commonly all bare patches of sand are covered with brush, particularly dune blowouts, which are the favoured nesting habitat of Hooded Plovers. Removal of brush matting once native plants have regenerated underneath helps return habitat to its original condition, and may mean that the negative impacts of brush matting on habitat availability can be reversed. However, this is rarely carried out in practice and the loss of habitat over the years it takes for native plants to regenerate can result in territories becoming unoccupied.

Brush matting is particularly common around access points and dune blowouts, and varies in occurrence across the Victorian coast. Typically, the more highly utilized a beach, the more likely measures to control dune erosion are implemented, particularly when residential development occurs in the coastal hinterland. In areas where land managers are aware of the conflict of erosion control works and preservation of Hooded Plover habitat, there are efforts to use alternative measures such as fencing of dune blowouts or small amounts of brush matting arranged so as to still give the birds access to the dunes.

Litter

For Hooded Plovers the risks include entanglement of adults and chicks in fishing line or fibres from commercial fishing nets that wash ashore, and injury or death resulting for this entanglement. There have been multiple entanglements reported especially along the South Gippsland coastline, resulting in loss of toes and feet, as well as mortality of adults. Poor management of litter adjacent to beaches, such as in caravan parks or rubbish tips, can result in superabundant native predator populations (e.g. silver gulls, ravens, magpies). Litter on beaches, such as bait bags, can also attract predators to forage along the beach and increase the likelihood of opportunistic encounters with Hooded Plover eggs and chicks.

Remote camera images have also revealed that Hooded Plovers will carry out distraction displays and be disturbed from the nest when litter such as plastic bottles and cans blow past the nest (Mead 2012). This may contribute to levels of disturbance experienced.

Driftwood Removal

Driftwood removed for firewood or for other purposes (e.g. decorating the garden, use in reptile cages or aviaries) can result in the crushing of nests and young chicks, which frequently crouch by driftwood to hide from predators and people. Nests have been crushed by people dragging driftwood along the beach for firewood (U.S. Fish and Wildlife Service 2007). Night-time wood collection increases the risk of stepping on nests and chicks, which are difficult to see even during daylight hours.

Furthermore, driftwood forms an important component of beach-nesting bird habitat, contributing to dune-building and adding organic matter to the sand as it decays (Washington Department of Fish and Wildlife 1995). Additionally, driftwood provides adults and chicks with shelter from wind and blowing sand and adults often build their nests beside driftwood (Marchant and Higgins 1993; U.S. Fish and Wildlife Service 2007; Mead 2012).

Driftwood collection occurs at low frequencies and is not commercially permitted.

Rodents – introduced and native

Rats are common predators of ground-nesting birds, and in New Zealand have been a major predator of shorebirds, many of which are now highly threatened (Dowding and Murphy 2001). Norway Rats have been reported predating nests of New Zealand Dotterel (Wills *et al.* 2003) and were identified as the predator at 35 % of predated Pied Stilt (*Himantopus himantopus*) and Black Stilt nests in New Zealand (Pierce 1986). Rats have been suspected of predating Hooded Plover eggs in Victoria (M. Weston pers.

comm.; B. Baird pers. comm.) and Tasmania (Berry 2001; Hanisch 1998). Rats could potentially predate newly-hatched chicks.

Rodent depredation was a common cause of egg depredation of model (quail) eggs placed in dune systems along the Victorian coast (Cribbin 2012), however, there was only one record of a water rat depredating a real Hooded Plover nest (at Phillip Island) in the study using remote cameras on 64 nests (Mead 2012). Further to this, Cribbin (2012) explored the key habitat differences between these artificially placed nests versus real Hooded Plover nests to see if the birds might be deliberately selecting habitat features so as to minimise risks of rodent depredation. There were two key variables reducing the likelihood of rodent depredation: real nests were more likely to be closer to dead objects than those sites selected by a researcher, and more likely to have less grass cover than those sites selected by a researcher. Furthermore, real Hooded Plover nests were significantly closer to the foredune than artificial nests.

Vehicles (air)

Low-flying aircraft (e.g. within 152 m of the ground) can cause disturbances to breeding and wintering Western Snowy Plovers and the noise of helicopters can be disturbing from greater altitudes (Howard *et al.* 1993; U.S. Fish and Wildlife Service 2007). Hatch (1997) found that all types of low-flying aircraft may potentially be perceived as predators by Western Snowy Plovers.

Hooded Plovers have been observed flushing from the nest when low flying aircraft passed overhead. Incubating birds respond similarly to hang gliders as they would an aerial (avian) predator, e.g. by standing over the nest, becoming vigilant and alert and flushing from the nest when the glider passes overhead (M. Weston pers. comm.; G. Ehmke pers. comm.). In some areas, beach-nesting birds may become habituated to aircrafts flying overhead, such as some pairs of Western Snowy Plovers (U.S. Fish and Wildlife Service 2007) and Hooded Plovers that have been observed nesting by runways (B. Semmens pers. comm.).

Hang gliding areas are highly localised along the Victorian coast, for example at Portsea within the Mornington Peninsula National Park and along sections of the Great Otway National Park.

Vehicles (water)

Recreational activities that occur in or over water (such as kayaking, wind surfing, jet skiing and boating) may not directly affect beach-nesting birds, as observational evidence indicates that the birds are less responsive to threats that are water based. This has not been further explored via standardized approaches to measure flight

initiation distances. Water based activities become detrimental when recreationists use the beach to take a break from these activities or as access, exit or launching points. The noise of motorised boats and jet skis may disturb beach-nesting birds, e.g. Piping Plovers (U.S. Fish and Wildlife Service 2003).

Sea level rise

This is a potential threat, though the extent and outcomes are unknown and limited modelling of the potential areas of impact is available. Sharples (2006) developed indicative mapping of areas of the Tasmanian coast that were vulnerable to sea level rise and climate change. Approximately 34% of Tasmania's coast line was classified as "Open coast Sandy Shores" and found to be potentially vulnerable to erosion and recession with sea level rise (Sharples 2006). Whilst this is not a direct measure of the impacts of climate and sea level changes on Hooded Plovers, it is indicative of the potential changes to habitat modification that this species may encounter in the future.

Natural threats

Threats that are considered 'natural' are those which are presumed to still occur at the same frequencies and intensities as before human settlement of the coast. For some threats, such as raven and silver gull depredation, parts of the coast are still thought to have natural population levels of these predators while in other areas they have become superabundant due to human modification of habitat. These threats are therefore considered in both the human-related and natural threat sections.

High Tides

Flooding of nests by high tides appears to be an important contributor to the loss of clutches (McGarvie and Templeton 1974; Murlis 1989; Stewart 1989; Ressom 2001). High tides have been recorded washing out eggs in 16% of 64 nests monitored by remote camera across Victoria (Mead 2012) and 25.9% of 521 nests monitored by observers (BirdLife Australia data 2006/07 – 2010/11 seasons). Dowling and Weston (1999) and Weston (2000), on the other hand, found that only 2% of 295 Hooded Plover nests were flooded in Victoria, and about 7 % of 79 nests were flooded in Tasmania (Hanisch 1998, Weston 2003). The relative importance of tidal inundation of nests can be difficult to calculate. It can either be overestimated, as it is one of the easiest causes of failure to identify, or underestimated, because many nests are lost to tides before they are detected. Flooding of nests may become more frequent as sea levels rise, and may be becoming more prevalent as dune habitats become less suitable for nesting, due to human modifications such as Marram Grass infestations and brush matting.

Chicks can be washed out to sea by freak waves and drown, especially when feeding at the water's edge or out on a rock platform. A drowned Hooded Plover chick was found at the high-tide mark on a beach in Anglesea, Victoria; the chicks at this territory were frequently observed foraging at the edge of rock platforms and were often left unattended as parents busily distracted passing people and dogs (G. Maguire pers. obsv.). Hooded Plover broods on the beach have also been seen to be hit by large waves, and chicks washed seaward before they were able to escape (M. Weston pers. comm.). Oystercatcher chicks may be less vulnerable to drowning, as they are known to swim up to 150 m across lagoons and lakes (NSW National Parks and Wildlife Service 2007, 2008). Hooded Plover chicks are known to swim across estuaries but it is unknown how far they can swim and whether they are strong enough swimmers to cope with wave wash.

Storms and extreme weather

Storm events can result in tidal surges, which increase the likelihood of nests becoming inundated. Storms also bring wild weather that can intensify the impacts of thermal stress on eggs and chicks. Coupled with disturbance, the eggs can be quickly buried in strong winds; Hooded Plover nests have been almost three quarters buried by sand within 10 minutes of the parent being absent due to disturbance (G. Maguire pers. obsv.) and once eggs are completely buried, the parents generally abandon the nest (G. Maguire pers. obsv.). On days of extreme heat (over 30º C) and extreme cold (less than 15º C), the eggs and chicks can quickly perish in the absence of incubating and brooding. The impacts of extreme weather can be further intensified by habitat modification, specifically the absence of cover such as driftwood.

Avian predators

Avian predators can depredate eggs and chicks, and larger raptors and ravens can prey upon adult birds. In the human-related threats section, the impacts of ravens, gulls and magpies are presented. In areas of the coast that are less populated by people, these avian predators may occur in pre-settlement densities and depredation levels are expected to be at natural levels (which the birds would have evolved with).

Birds of prey

Nankeen Kestrels (*Falco cenchroides*) and Swamp Harriers (*Circus approximans*) were recorded, via remote cameras, predating on Hooded Plover eggs (Mead 2012), while Nankeen Kestrels have also been observed predating Hooded Plover chicks in at least three observations (Weston 1998; Duivenvoorden 2007).

Peregrine Falcons (Schulz 1992b), Black-shouldered Kites (*Elanus axillaris*), Swamp Harriers (*Circus approximans*) and Whistling Kites (*Haliastur sphenurus*) have been implicated in the disappearance of Hooded Plover and Pied Oystercatcher chicks in NSW (NSW National Parks and Wildlife Service 2007, 2008). Observations have also been made of Nankeen Kestrels predating Pied Oystercatcher chicks, and a White-bellied Sea-eagle (*Haliaeetus leucogaster*) predating an injured Pied Oystercatcher adult (NSW National Parks and Wildlife Service 2007).

As an indirect indication of the severity of threats we can also consider the reactions of Hooded Plover when threats are present. Hooded Plover ceased brooding in 33% of encounters with birds of prey (Weston and Elgar 2005a) and chicks reacted strongly to the presence of birds of prey, almost as strongly as for people, dogs and horses. They were also more likely to run further distances towards the dune to hide than when responding to encounters with other birds (Duivenvoorden 2007).

Other birds

A number of other bird species may contribute to nest failure of beach-nesting birds. Pied Oystercatchers have been observed predating Hooded Plover eggs (Weston 2003).

Masked Lapwings (*Vanellus miles*) have been observed destroying four New Zealand Dotterel clutches, pecking one to two small holes in each egg (Wills *et al.* 2003). Australian White Ibis (*Threskiornis molucca*) and Straw-necked Ibis (*T. spinicollis*) are known to forage on beaches and have been suggested as a potential predator of beach-nesting bird eggs (B. Baird in litt. cited in Weston 2003). However, in a comprehensive review of the diet of both ibis species, neither was recorded eating young birds or eggs, but they will sometimes eat small mammals (Marchant and Higgins 1990). Ibis could potentially crush the eggs of smaller beach-nesting bird species, as they forage over extensive areas of the upper beach and dunes (Weston 2003; G. Maguire pers. obsv.). Emus (*Dromaius novaehollandiae*) are another bird that occasionally traverse within dunes and on beaches and could potentially crush nests. Burger (1987) suggests that by nesting near more aggressive nest defenders, such as terns, beach-nesting shorebirds may experience greater nesting success. However, this is questionable as birds may spend a lot of time defending their nests from the terns themselves (Flemming 1987). Little Terns (*Sternula albifrons*) have been observed harassing nesting Hooded Plovers, which resulted in high levels of disturbance (NSW National Parks and Wildlife Service 2006).

Conspecifics (members of the same species) are also a source of potential disturbance and cause of nest failure. Intruding Hooded Plovers have been observed dive-bombing and striking Hooded Plover chicks, resulting in lengthy aggressive encounters between the parents and intruders (Teoh and Weston 2002; G. Ehmke pers. comm.). On the Mornington Peninsula in Victoria, the frequent and lengthy territorial disputes between Hooded Plovers and a small flock of non-breeding Hooded Plovers were thought to have

contributed to the loss of a brood of four, due to the brood being left unattended for long periods (G. Maguire pers. obsv.). On one occasion, a neighbouring pair of Hooded Plovers attacked and killed a Hooded Plover chick (M. Cullen pers. comm.). The loss and modification of habitat may enhance territorial disputes between beach-nesting birds, as they may be forced to nest closer to one another or be left without a breeding territory. The increasing population of Hooded Plovers in the Mornington Peninsula is thought to be a result of modification of habitat and dispersal barriers, which highlights the need to ensure that habitat is being rehabilitated and dispersal barriers restored or maintained.

Reptilian Predators

Goannas and lace monitors have been identified as predators of Hooded Plover and Pied Oystercatcher eggs (Lashmar 1984; Bransbury 1991; Schulz 1995; NSW National Parks and Wildlife Service 2006, 2007, 2008). Snakes are also suspected of taking Hooded Plover eggs (Weston 2003).

There is no evidence to suggest that natural rates of reptilian predation have increased; for example on Kangaroo Island, goanna numbers have remained stable over time (Dennis and Masters 2006).

In Victoria, lace monitors (*Varanus varius*) are restricted to the East Gippsland coast.

Spatial variation of threats

There is considerable variation in the occurrence and intensity of threats across sites in Victoria revealed by detailed threat records collected over time through BirdLife Australia's Beach-nesting Birds Program. For example, the prevalence of a given threat can vary regionally across the Victorian coast but also along an individual stretch of beach. Below the spatial variation of threats is considered across two scales: individual parks and individual sites.

Park by Park threat profiles

Below, five seasons (2006/07 – 2010/11) of threat data across 74 sites on Parks Victoria managed beaches are discussed. A minimum of ten threat assessments per site was required for inclusion.

Across all monitored Hooded Plover breeding sites on Parks Victoria managed land, people (i.e. recreational users) and dogs were the most frequent threats observed (Table 11). Prints left by people and dogs were recorded more frequently (82.95% and 48.86% of visits, respectively) than actual observations of people and dogs (e.g. 52.27% of visits where people were observed). This is presumably related to the short term duration of

visits by observers (average visit duration 15 minutes) compared to the latency of prints in the sand, where beaches can act as 'sand pads' for measuring prior use.

Where dogs were sighted, dogs off leash were 2.5 times more common than dogs on leash (18.85% versus 7.73%). Dogs off leash, foxes and horses were observed at similar frequencies, in around 18% of visits across all parks combined. Magpies, vehicles and ravens were detected at the lowest frequencies, in around 6% of total visits across all parks combined.

Table 11. Proportion of visits to all parks where threats were observed (this includes evidence of their presence, e.g. prints, unless otherwise specified).

THREAT	**PROPORTION VISITS PRESENT (TOTAL VISITS=3103)**
Evidence of people (prints)	82.95% (2574)
People sighted	52.27% (1622)
Evidence of dogs (prints &/or sightings)	48.86% (1516)
Dogs off lead	18.85% (585)
Foxes	17.82% (553)
Horses	17.69% (549)
Dogs on lead	7.73% (240)
Magpies	6.35% (197)
Vehicles	5.99% (186)
Ravens	5.58% (173)

The above frequencies of the different threats are likely to be influenced by how detectable that threat type is (ease of observation) and the duration of time the particular threat is present in the environment (so how likely it will be that the threat is observed within a 15 minute visit). However, due to multiple visits across five breeding seasons, it is likely that these frequency values are a strong *indicator* of the presence of these threats. It must be noted that an absence of a particular threat in a park indicates either its true absence from that area or that it occurs in such low frequencies that the probability of detection was very low.

Table 12 reveals that people (and footprints), dog prints and silver gulls were present in all parks monitored (this does not mean they were present at all sites within parks). Observations of dogs occurred in all parks monitored with only one exception, Point Nepean National Park where dogs are prohibited.

Foxes, dogs off lead and avian predators were the next most common threat across all sites. This is despite the majority of parks monitored having dog access on the requirement that dogs be on a leash within the park. Horses and vehicles were the least observed threat type. Horses occurred within 57% of parks monitored and vehicles 42% of parks. Where vehicles were recorded, only 28.57% of parks had evidence of illegal vehicle access (n=4 parks).

Table 12. Proportion of parks where threats were observed. Tracks and prints are included as evidence of threats, unless categorised separately. An asterisk denotes where vehicles detected were legal management vehicles only. All other parks listed with evidence of vehicles included illegal vehicle access.

THREAT	% PARKS PRESENT (14 PARKS)	DETECTED AT:	NOT DETECTED AT:
People	100.00%	All	
Human prints	100.00%	All	
Dog prints	100.00%	All	
Silver gulls	100.00%	All	
Foxes	92.86%		Narrawong Coastal Reserve
Dogs sighted	92.86%		Point Nepean National Park
Pacific gulls	92.86%		Gippsland Lakes Coastal Park
Dogs off lead	85.71%		Cape Conran Coastal Park, Point Nepean National Park
Ravens	85.71%		Bunurong Coastal Reserve, Point Nepean National Park
Magpies	78.57%		Gippsland Lakes Coastal Park, Point Nepean National Park, Port Campbell National Park
Bird of Prey	78.57%		Bay of Islands Coastal Park, Bunurong Coastal Reserve, Eumeralla (Yambuk) Coastal Reserve, Gippsland Lakes Coastal Park
Dogs on lead	71.43%		Bay of Islands Coastal Park, Gippsland Lakes Coastal Park, Point Nepean National Park, Port Campbell National Park
Horses	57.14%	Bay of Islands Coastal Park, Belfast Coastal Reserve, Cape Liptrap Coastal Park, Eumeralla (Yambuk) Coastal Reserve, Kilcunda – Harmers Haven Coastal Reserve, Lakes Entrance-Lake Tyers Coastal Reserve, Mornington Peninsula National Park, Narrawong Coastal Reserve	
Vehicles	42.86%	Bay of Islands Coastal Park, Belfast Coastal Reserve, Cape Liptrap Coastal Park*, Kilcunda – Harmers Haven Coastal Reserve*, Mornington Peninsula National Park, Narrawong Coastal Reserve	

When the frequency of occurrence of different threats is considered for each individual park (excluding people which were present across all parks and the majority of visits), it becomes clear that the dominant threats vary greatly across parks (Table 13). Foxes are the most consistently recorded threat within nine of the 14 monitored parks. Dogs off leash are recorded at the highest frequency of occurrence across all parks combined; however, this is highly variable between individual parks. Dogs off lead were the most dominant threat type in Lakes Entrance – Lake Tyers, Eumeralla (Yambuk) and Narrawong Coastal Reserves, but were also the second most frequently occurring threat in five additional parks including two high land reservation status parks: Cape Liptrap Coastal Park and Mornington Peninsula National Park.

Overall, native (avian) predators were recorded less frequently than introduced (mammalian) predators. Cape Liptrap Coastal Park and Port Phillip Heads Marine National Park had exceptionally high occurrences of magpies. Gippsland Lakes Coastal Park, Lakes Entrance – Lake Tyers Coastal Reserve, Narrawong Coastal Reserve and Port Campbell National Park had high occurrences of ravens relative to other parks.

Most distinctive of any park threat profile was that of Belfast Coastal reserve, where horses were present on 66.27% of visits. Vehicle use was also highest in Belfast Coastal Reserve, as well as in Narrawong Coastal Reserve. In both of these coastal reserves, the observed vehicle access is that of illegal recreational access.

Table 13. The main threats (excluding general recreationists) observed at Parks Victoria managed beaches across five breeding seasons (2006/07 – 2010/11). An asterisk denotes where vehicles detected were legal management vehicles only.

PARK NAME (N= NUMBER OF THREAT ASSESSMENTS CARRIED OUT)	THREAT	% OCCURRENCE
Bay of Islands Coastal Park (2 pairs, n=119)	**Fox**	**34.45% (41)**
	Raven	5.88% (7)
	Horse	5.04% (6)
	Dog off lead	5.04% (6)
	Vehicle	0.84% (1)
Belfast Coastal Reserve (21 pairs, n=667)	**Horse**	**66.27% (442)**
	Dog off lead	31.78% (212)
	Vehicle	19.79% (132)
	Fox	11.54% (77)
	Dog on lead	10.79% (72)
	Raven	8.25% (55)
	Magpie	2.70% (18)
Bunurong Coastal Reserve (3 pair, n=49)	**Fox**	**20.41% (10)**
	Dog off lead	8.16% (4)
	Magpie	2.04% (1)
	Dog on lead	2.04% (1)

PARK NAME (N= NUMBER OF THREAT ASSESSMENTS CARRIED OUT)	THREAT	% OCCURRENCE
Cape Conran Coastal Park (2 pairs, n=48)	**Fox**	**58.33% (28)**
	Raven	18.75% (9)
	Magpie	2.08% (1)
	Dog on lead	2.08% (1)
Cape Liptrap Coastal Park (3 pairs, n=172)	**Fox**	**26.74% (46)**
	Dog off lead	21.51% (37)
	Magpie	19.19% (33)
	Vehicle*	10.47% (18)
	Dog on lead	8.72% (15)
	Horse	3.49% (6)
	Raven	2.33% (4)
Eumeralla (Yambuk) Coastal Reserve (1 pair, n=23)	**Dog off lead**	**26.09% (6)**
	Fox	**26.09% (6)**
	Raven	17.39% (4)
	Dog on lead	13.04% (3)
	Horse	4.35% (1)
Gippsland Lakes Coastal Park (1 pair, n=10)	**Fox**	**50.00% (5)**
	Raven	40.00% (4)
	Magpie	10.00% (1)
	Dog off lead	10.00% (1)
Kilcunda – Harmers Haven Coastal Reserve (10 pairs, n=330)	**Fox**	**29.70% (98)**
	Dog off lead	20.91% (69)
	Raven	9.09% (30)
	Dog on lead	8.79% (29)
	Horse	2.12% (7)
	Magpie	2.12% (7)
	Vehicle*	0.30% (1)
Lakes Entrance – Lake Tyers Coastal Reserve (2 pairs, n=58)	**Dog off lead**	**37.93% (22)**
	Fox	**37.93% (22)**
	Raven	34.48% (20)
	Dog on lead	20.69% (12)
	Horse	6.90% (4)
	Magpie	1.72% (1)
Mornington Peninsula National Park (26 pairs, n=1422)	**Fox**	**13.71% (195)**
	Dog off lead	13.57% (193)
	Magpie	7.74% (110)
	Dog on lead	5.63% (80)
	Horse	5.13% (73)
	Vehicle	1.27% (18)
	Raven	0.91% (13)
Narrawong Coastal Reserve (2 pairs, n=103)	**Dog off lead**	**18.45% (19)**
	Raven	**18.45% (19)**
	Vehicle	15.53% (16)
	Horse	9.71% (10)
	Dog on lead	3.88% (4)
	Magpie	0.97% (1)
Point Nepean National Park (1 pair, n=11)	**Fox**	**27.27% (3)**

PARK NAME (N= NUMBER OF THREAT ASSESSMENTS CARRIED OUT)	THREAT	% OCCURRENCE
Port Campbell National Park (1 pair, n=21)	**Fox**	**95.24% (20)**
	Raven	19.05% (4)
	Magpie	9.52% (2)
	Dog off lead	4.76% (1)
Port Phillip Heads Marine National Park * (1 pair, n=70)	**Dog on lead**	**34.29% (24)**
	Magpie	31.43% (22)
	Dog off lead	21.43% (15)
	Raven	5.71% (4)
	Fox	2.86% (2)
All parks (n=3103)	**Dog off lead**	**18.85% (585)**
	Fox	17.82% (553)
	Horse	17.69% (549)
	Dog on lead	7.73% (240)
	Magpie	6.35% (197)
	Vehicle	5.99% (186)
	Raven	5.58% (173)

Intensity of human and dog use

There were four parks containing the bulk of monitored pairs where a high number of threat assessments carried out has meant that estimates of the average number of people and dogs using the parks can be calculated (Table 14). These averages should not be interpreted directly as representative of total park use, however, are strong indicators of *relative use* of the different parks.

Cape Liptrap had the highest number of people on average recorded, but this average had the highest standard error, suggesting strong temporal variation in park use. Pipi collection and overall park use seems to peak in summer and holiday periods, but at other times the park attracts fewer users. The Mornington Peninsula had high use compared to the other parks, and this was consistent across visits (with a small standard error).

Dogs off leash were always in higher abundance than dogs on leash at Hooded Plover beaches within the four monitored parks. Each park has very different sets of regulations and these are variable across sites within parks. There are dogs prohibited areas and dogs on leash areas within Cape Liptrap Coastal Park; dogs prohibited, time restricted leash only access, and seasonal leash only access in the Mornington Peninsula National Park; dogs on and off leash access in Belfast Coastal Reserve, and dogs on leash access in Kilcunda – Harmers Haven coastal reserve. Belfast coastal reserve had the greatest number of dogs off leash, with over four times more off leash than on leash. This is more consistent with the dog regulations within this park, in particular it being the only park where off leash access is permitted. However, in the remaining parks where dogs off leash are not permitted, the ratio of off to on lead dogs is highly variable. Cape Liptrap Coastal Park appears to have better leashing rates than the other parks, with only twice as many dogs being off leash. Kilcunda and Mornington Peninsula have more than three

times as many dogs off leash than on leash, despite very different land reservation status (i.e. a coastal reserve versus a National Park).

Table 14. Mean (± standard error) number of people and dogs on and off leash observed at Hooded Plover sites monitored within four parks across five seasons. Only parks with more than three Hooded Plover pairs monitored were included.

PARK	PEOPLE	DOGS ON LEASH	DOGS OFF LEASH	DOGS OFF/DOGS ON
Belfast Coastal Reserve (21 pairs, n=667)	3.15 ± 0.45	0.16 ± 0.02	0.67 ± 0.05	4.19
Mornington Peninsula National Park (26 pairs, n=1422)	6.70 ± 0.48	0.10 ± 0.02	0.31 ± 0.03	3.10
Kilcunda – Harmers Haven Coastal Reserve (10 pairs, n=330)	2.18 ± 0.27	0.13 ± 0.02	0.46 ± 0.06	3.54
Cape Liptrap Coastal Park (3 pairs, n=172)	8.19 ± 3.10	0.14 ± 0.04	0.27 ± 0.06	1.93

Dominant recreational activities

When people were observed on Hooded Plover beaches, the recreational activity they were undertaking was recorded. Of close to 18,000 observations of recreationists (Table 15), walking was the most common activity occurring across all parks (42.13% of people) and the next two most popular categories were sitting/sunbaking (19.55%) and swimming/surfing (17.61%). Fishing and dog walking were next in popularity, at around 8% of recreational users (Table 15).

The prevalence of each recreational group was, however, highly variable across parks (Table 15). For example, in some parks, anglers were the dominant user group. Cape Liptrap Coastal Park had one of the most distinctive profiles, with pipi collectors dominating park use. Belfast Coastal Reserve similarly had a unique profile where horse riding featured more highly than in any other park. The parks where dog walking was the prevalent activity were typically coastal reserves, namely Yambuk, Kilcunda-Harmers Haven and Lake Tyers coastal reserve.

Jetskiing was only recorded at Point Nepean National Park, and dune boarding was only recorded within Kilcunda – Harmers Haven Coastal Reserve, Cape Liptrap Coastal Park, Mornington Peninsula National Park, Eumeralla (Yambuk) Coastal Reserve and Belfast coastal reserve.

Table 15. The main recreational activities people were observed participating in across monitored Hooded Plover sites in the different parks across the Victorian coast. In total, 17,931 people were observed over five seasons of data collection (2006/07 – 2010/11).

PARK (N = NUMBER OF THREAT ASSESSMENTS CARRIED OUT)	RECREATIONAL ACTIVITY	% OCCURRENCE
Bay of Islands Coastal Park (2 pairs, n=119)	**Anglers**	**52.78% (76)**
	Swim/Surf	27.78% (40)
	Sitting/Sunbaking	10.42% (15)
	Walkers	5.56% (8)
	People playing games	2.08% (3)
	Dog walkers	1.39% (2)
Belfast Coastal Reserve (21 pairs, n=667)	**Walkers**	**58.40% (1203)**
	Dog walkers	17.33% (357)
	Anglers	12.14% (250)
	Horses	11.02% (227)
	Swim/Surf	4.22% (87)
	Sitting/Sunbaking	1.99% (41)
	Dune boarding	0.19% (4)
	Jetski/Windsurfing	0.05% (1)
	Quad Bike/4WD	0.05% (1)
Bunurong Coastal Reserve (3 pair, n=49)	**Sitting/Sunbaking**	**46.07% (88)**
	Swim/Surf	38.74% (74)
	Walkers	9.42% (18)
	Dog walkers	4.19% (8)
	People playing games	1.57% (3)
Cape Conran Coastal Park (2 pairs, n=48)	**Anglers**	**69.70% (23)**
	Sitting/Sunbaking	12.12% (4)
	Walkers	9.09% (3)
	Dog walkers	6.06% (2)
	Swim/Surf	3.03% (1)
Cape Liptrap Coastal Park (3 pairs, n=172)	**Pipi collectors**	**42.68% (598)**
	Walkers	19.49% (273)
	Sitting/Sunbaking	16.56% (232)
	Anglers	10.85% (152)
	Swim/Surf	5.64% (79)
	Dog walkers	3.78% (53)
	People playing games	0.57% (8)
	Trail bike riders	0.57% (8)
	Quad Bike/4WD	0.43% (6)
	Dune boarding	0.43% (6)
Eumeralla (Yambuk) Coastal Reserve (1 pair, n=23)	**Dog walkers**	**40.00% (20)**
	Walkers	26.00% (13)
	Sitting/Sunbaking	22.00% (11)
	Anglers	8.00% (4)
	Dune boarding	4.00% (2)
Gippsland Lakes Coastal Park (1 pair, n=10)	**Walkers**	**100.00% (8)**

PARK (N = NUMBER OF THREAT ASSESSMENTS CARRIED OUT)	RECREATIONAL ACTIVITY	% OCCURRENCE
Kilcunda – Harmers Haven Coastal Reserve (10 pairs, n=330)	**Walkers**	**29.05% (208)**
	Dog walkers	21.79% (156)
	Anglers	18.58% (133)
	Swim/Surf	15.36% (110)
	Sitting/Sunbaking	13.41% (96)
	Dune boarding	3.35% (24)
	Horses	0.42% (3)
Lakes Entrance – Lake Tyers Coastal Reserve (2 pairs, n=58)	**Anglers**	**47.73% (158)**
	Walkers	28.40% (94)
	Dog walkers	18.73% (62)
	Sitting/Sunbaking	3.32% (11)
	Swim/Surf	1.51% (5)
Mornington Peninsula National Park (26 pairs, n=1422)	**Walkers**	**51.25% (4846)**
	Swim/Surf	20.04% (1990)
	Sitting/Sunbaking	17.29% (1635)
	Dog walkers	5.49% (519)
	Anglers	4.39% (415)
	Horses	1.87% (177)
	People playing games	0.75% (71)
	Dune boarding	0.35% (33)
	Kite Flying	0.03% (3)
	Quad Bike/4WD	0.01% (1)
Narrawong Coastal Reserve (2 pairs, n=103)	**Walkers**	**44.48% (278)**
	Swim/Surf	21.28% (133)
	Anglers	18.40% (115)
	Dog walkers	8.16% (51)
	Sitting/Sunbaking	7.52% (47)
	Horses	0.64% (4)
	People playing games	0.16% (1)
Point Nepean National Park (1 pair, n=11)	**Swim/Surf**	**51.28% (20)**
	Jetski/Windsurfing	20.51% (8)
	Anglers	15.38% (6)
	Walkers	12.82% (5)
Port Campbell National Park (1 pair, n=21)	**Anglers**	**48.33% (29)**
	Walkers	31.67% (19)
	Sitting/Sunbaking	13.33% (8)
	Swim/Surf	3.33% (2)
	Dog walkers	3.33% (2)
Port Phillip Heads Marine National Park* (1 pair, n=70)	**Sitting/Sunbaking**	**57.66% (1159)**
	Swim/Surf	23.63% (475)
	Walkers	11.84% (238)
	Dog walkers	3.33% (67)
	People playing games	2.19% (44)
	Anglers	1.34% (27)

PARK (N = NUMBER OF THREAT ASSESSMENTS CARRIED OUT)	RECREATIONAL ACTIVITY	% OCCURRENCE
All Parks (n=3103)	**Walkers**	**42.13% (7214)**
	Sitting/Sunbaking	19.55% (3347)
	Swim/Surf	17.61% (3016)
	Anglers	8.11% (1388)
	Dog walkers	7.59% (1299)
	Pipi collectors	3.49% (598)
	Horses	2.40% (411)
	People playing games	0.76% (130)
	Dune boarding	0.40% (69)
	Jetski/Windsurfing	0.05% (9)
	Trail bike riders	0.05% (8)
	Quad Bike/4WD	0.05% (8)
	Kite Flying	0.02% (3)

Within park threat variation – site by site considerations

The distribution of threats within parks can vary greatly, and where human-related threats are concerned, can relate to the presence of access points, ease of access (e.g. length of access path), proximity to residential areas, and recreational zoning (i.e. regulations).

For each site where greater than ten threat assessments were carried out over five breeding seasons, the frequency of occurrence (number of visits where present) of vehicles, foxes, horses, ravens and magpies was calculated and standardized by the total number of visits. The percentage frequency of occurrence of each threat was ranked in categories from low to very high (Table 16). For dogs off leash, dogs on leash and people, actual numbers of these threats were recorded on each site visit so that we calculated an average value and then divided this by the maximum recorded values for each threat to determine a *relative* threat rank (Table 16). It becomes clear that each site, even within the same park, can have a very different threat profile. At some sites, one threat can be far more dominant than another, while at other sites, all threats can occur at similar levels, either in low frequencies or high frequencies.

Two methods of formulating threat indices were used in order to consider how threatened sites are relative to one another. The first index is simply the sum of ranks assigned to each threat type as per Table 16. The second is a *weighted* threat index where the rank assigned to each threat (representing its frequency of occurrence at a site, Table 16) is multiplied by the impact rating of that threat (taken from Table 10; e.g. horse impact = 4; magpie impact = 2). Appendix 7 presents sites in order of the highest weighted threat index to the lowest. The two indices do not differ greatly. It is most interesting to note that sites in the Belfast Coastal Reserve appear to be the most

heavily threatened in the state, particularly around Rutledges Cutting, Levys beach and the Basin.

Figures 12 to 19 allow for spatial visualization of the ranks assigned in Table 16, where colour codes indicate the frequency of occurrence ranks from green to red (low to high frequency).

Vehicles are most prevalent within the Belfast Coastal Reserve and appear to be clustered around The Basin and Rutledges Cutting (Figure 12). On the Mornington Peninsula, vehicle access is predominantly land manager access, including Hooded Plover rangers on quad bikes who erect fencing and signage around nest sites, and fox baiting contractors.

Within the Belfast Coastal Reserve, horse access is widespread and frequent in occurrence. This is strikingly different compared to any other park (Figure 17).

Figure 13 shows dogs off leash at high frequencies along much of the Victorian coast. Of greatest concern is the pattern of use within the Mornington Peninsula National Park where the frequency of off-leash dogs varies greatly across the park; being lowest in dog prohibited areas and highest in on-leash dog access areas (note off leash dogs are not permitted anywhere within the park). The locations of the highest frequency off-leash dog use correspond exactly with the locations where Hooded Plovers pairs experience the poorest breeding success (Figure 10). This spatial correlation between high off-leash dog use and the location of breeding sinks overlaps more closely than any other threat type (see Figures 12-19). This is the opposite trend for locations of high fox occurrence and breeding success (Figure 14; also see Appendix 8), i.e. foxes do not appear to limit breeding productivity and frequency of occurrence appears inversely related to frequency of dogs off-leash. This data suggests that off-leash dogs are the greatest contributing factor to the poor productivity experienced by Hooded Plovers within the Mornington Peninsula National Park. It is suspected that this threat is having greatest impact during the chick phase.

Table 16. The rank value assigned to each threat type (people: all recreational activities combined; dogs on leash; dogs off leash; vehicles - illegal and legal not distinguished; horses; foxes; ravens; magpies) for monitored sites across the Parks Victoria estate. Parks appear in order from west to east of the Victorian coast. The first threat index is simply the sum of the ranks assigned to each of the eight threat types in the table below. The second is a weighted threat index where the rank assigned to each threat (representing its frequency of occurrence at a site; in the table below) is multiplied by the impact rating of that threat (taken from Table 10; e.g. horse impact = 4; magpie impact = 2). Appendix 7 presents sites in order of their weighted index.

Name of Park	Site Name	People	Dog On	Dog off	Vehicle	Horse	Fox	Raven	Magpie	1. Sum threat ranks	2. Weighted threat index
NARRAWONG COASTAL RESERVE	Narrawong Surrey Estuary East	2	2	3	2	2	0	2	0	13	51
	Narrawong Surrey Estuary west	2	1	3	2	2	0	3	1	14	54
EUMERALLA (YAMBUK) COASTAL RESERVE	Yambuk Estuary East	1	3	3	0	1	3	2	0	13	48.5
BELFAST COASTAL RESERVE COASTAL	Killarney Basin Rusty Rocks 1	2	3	4	2	4	2	2	1	20	76
	Killarney Boat Ramp 1 (west of point)	1	1	2	0	3	2	0	0	9	34.5
	Killarney Boat Ramp 2 (east of point)	2	3	3	1	3	2	1	0	15	57
	Killarney Camping Ground West	2	3	3	0	3	2	0	0	13	48
	Killarney Midway	2	1	3	0	4	0	1	0	11	42
	Killarney Old Log Beach 1 (west end)	1	0	3	0	4	2	2	2	14	51.5
	Killarney Old Log Beach 2 (East End)	2	4	4	3	4	2	0	0	19	74
	Killarney Pelicans	2	3	3	3	4	2	2	1	20	77
	Port Fairy Mills Reef East (Golf Course)	1	0	4	0	3	2	2	1	13	49.5
	Port Fairy Mills Reef Far West	1	2	2	2	4	3	2	0	16	63.5

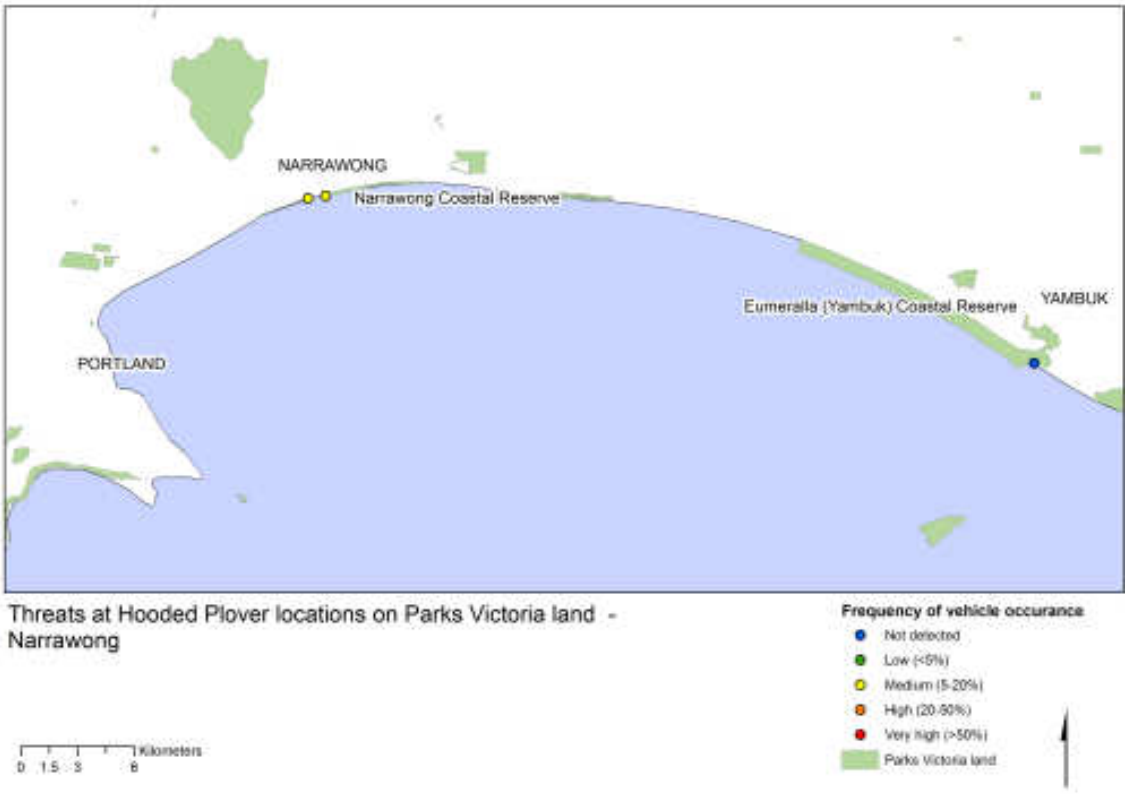
Name of Park	Site Name	People	Dog On	Dog off	Vehicle	Horse	Fox	Raven	Magpie	Sum threat ranks	Weighted threat index
BELFAST COASTAL RESERVE	Port Fairy Mills Reef West	2	2	3	2	4	2	2	1	18	69
	Tower Hill Gormans Rd West	1	3	3	3	4	2	0	0	16	63.5
	Tower Hill Rutledge Cutting East 1	2	0	4	3	4	3	2	2	20	78
	Tower Hill Rutledges Cutting (mouth)	1	2	4	4	4	2	2	2	21	81.5
	Tower Hill Rutledges Cutting West Pt	2	1	4	3	4	2	1	0	17	69
	Tower Hill Towilla East (Seachange)	2	1	2	2	4	1	0	0	12	48
	Tower Hill Towilla West (Seachange)	1	3	3	3	4	3	2	0	19	75.5
	Warrnambool Levys West 1	1	2	3	2	4	2	2	1	17	65.5
	Warrnambool Levys West 2	2	0	4	2	4	3	3	3	21	79
	Warrnambool Levys West 3	2	0	4	2	4	0	2	2	16	61
	Warrnambool Levys West 4	2	0	4	2	4	0	0	0	12	49
BAY OF ISLANDS COASTAL PARK	Crofts Bay	1	0	1	0	0	3	2	0	7	27.5
	Terry's Beach East	1	0	2	2	3	4	2	0	14	57.5
PORT CAMPBELL NATIONAL PARK	Clifton Beach	2	0	1	0	0	4	2	2	11	39
PORT PHILLIP HEADS MARINE NATIONAL PARK*	Point Lonsdale	4	4	3	0	0	1	2	3	17	56
POINT NEPEAN NATIONAL PARK	Sierra Nevada rocks/beach	2	0	0	0	0	3	0	0	5	19

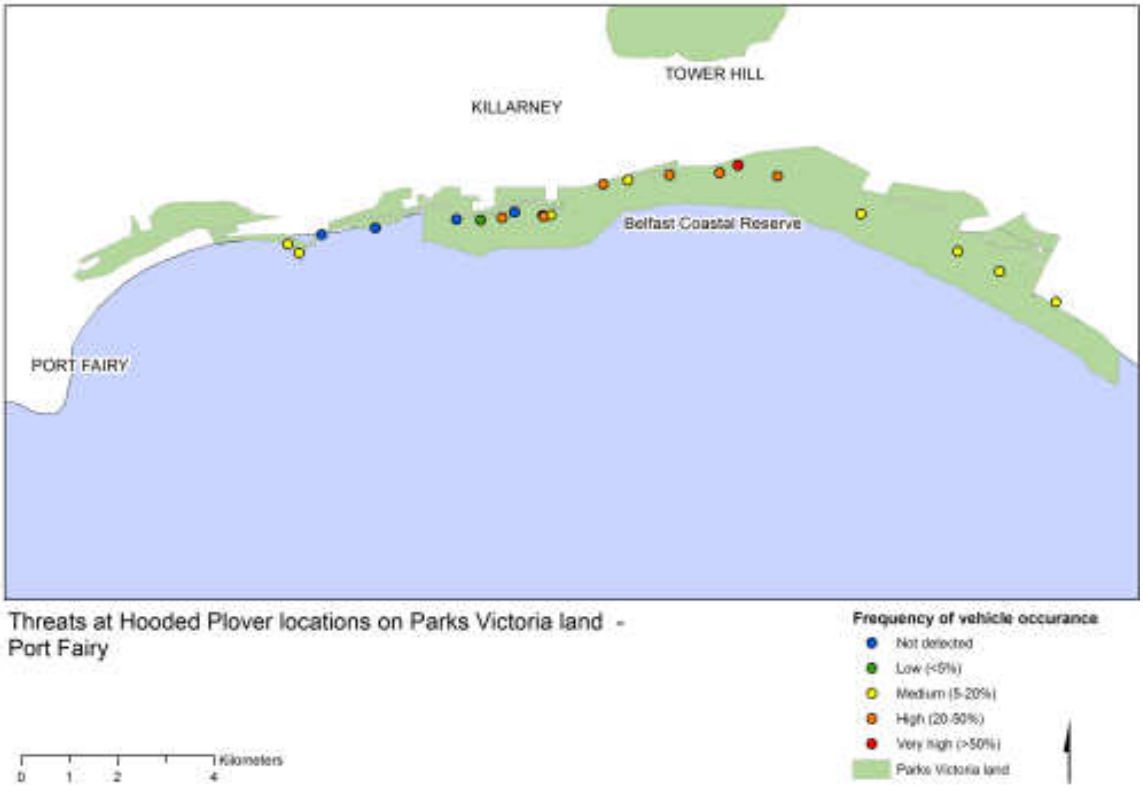
Name of Park	Site Name	People	Dog On	Dog off	Vehicle	Horse	Fox	Raven	Magpie	Sum threat ranks	Weighted threat index
MORNINGTON PENINSULA NATIONAL PARK	Alison ave east Rye	2	0	3	0	0	2	1	1	9	33
	Alison ave west Rye	1	0	0	0	0	3	0	0	4	15.5
	Gunnamatta Pair 1	2	0	2	1	0	3	1	2	11	40
	Gunnamatta Pair 2	2	0	0	2	0	3	1	2	10	37
	Gunnamatta Pair 3	2	0	0	1	0	3	1	2	9	32
	Gunnamatta Pair 4	2	0	0	2	0	3	0	3	10	35
	Gunnamatta Pair 5	1	0	0	1	1	3	0	3	9	30.5
	Gunnamatta Pair 6	3	0	1	0	0	1	0	2	7	22.5
	Heyfield Pair 1 (west side) Rye	2	2	4	0	0	2	0	2	12	41
	Koonya East	2	2	2	1	1	2	1	1	12	44
	Koonya West	2	3	3	1	1	2	1	1	14	51
	Miami drive east access	1	2	3	0	1	2	1	1	11	39.5
	Miami drive west (extra 2006-2008)	2	1	3	0	1	2	1	2	12	42
	Moana crt access (east edge)	2	2	3	0	2	2	1	1	13	47
	Moana crt east (St Andrews)	2	0	3	0	1	2	0	1	9	33
	Montforts	1	0	2	2	2	2	0	2	11	41.5
	Portsea Franklin rd access (west edge)	2	2	2	0	0	2	0	0	8	29
	Portsea Franklin rd East (Sphinx rocks end)	2	2	3	1	0	2	0	2	12	42

Name of Park	Site Name	People	Dog On	Dog off	Vehicle	Horse	Fox	Raven	Magpie	Sum threat ranks	Weighted threat index
MORNINGTON PENINSULA NATIONAL PARK	Portsea Franklin rd west	1	0	0	0	0	2	0	2	5	15.5
	Portsea London Bridge (MP)	3	2	2	1	1	2	0	2	13	45.5
	Portsea SLSC east	4	0	2	0	0	2	0	2	10	34
	Rye Big Rock	1	2	2	0	0	2	0	2	9	29.5
	Rye car park east	2	2	2	0	0	2	0	2	10	33
	Rye car park west	2	2	2	0	0	2	0	0	8	29
	St Andrews Boags Rocks	1	3	2	0	4	2	0	0	12	44.5
	St. Andrews car park east	2	2	3	1	4	2	0	1	15	56
KILCUNDA - HARMERS HAVEN COASTAL RESERVE	Coal Creek Estuary Mouth	1	3	3	0	1	2	2	1	13	46.5
	Cutlers Beach A20 East	1	2	3	0	2	3	3	2	16	57.5
	East 16	1	2	2	0	0	4	2	0	11	41.5
	Far West 16	1	2	2	0	0	3	0	0	8	29.5
	Powlett River Mouth East Bank	2	2	3	0	0	2	0	0	9	33
	Powlett River Mouth West Bank	1	1	2	1	0	3	0	1	9	33.5
	Waterfall Creek	1	3	3	0	1	2	3	1	14	50.5
	West 16	1	2	3	0	1	3	1	1	12	43.5
	Williamson's Beach West	1	3	4	0	0	2	0	0	10	36.5
	Wilsons Rd 2nd Bay West	2	3	4	0	0	3	2	0	14	52
BUNURONG COASTAL RESERVE	The Oaks	2	1	2	0	0	2	0	1	8	28

Name of Park	Site Name	People	Dog On	Dog off	Vehicle	Horse	Fox	Raven	Magpie	Sum threat ranks	Weighted threat index
GIPPSLAND LAKES COASTAL PARK	Barrier Landing	1	0	0	0	0	4	3	2	10	35.5
CAPE CONRAN COASTAL PARK	Marlo Mot's Beach	1	0	0	0	0	3	0	0	4	15.5
	Snowy River Estuary East	1	2	0	0	0	4	3	1	11	39.5
CAPE LIPTRAP COASTAL PARK	South of Six Mile Track	4	0	2	0	2	3	0	3	14	48
	Venus Bay South 1	2	3	2	2	1	3	1	2	16	58
	Venus Bay South 2	1	2	2	3	1	3	0	2	14	52.5
LAKES ENTRANCE - LAKE TYERS COASTAL RESERVE	Lake Bunga/Red Bluff	1	2	3	0	2	4	3	1	16	59.5
	Lake Tyers Beach	3	4	4	0	2	2	3	0	18	66.5

Figure 12. Vehicles (illegal and legal) recorded at Hooded Plover breeding locations on Parks Victoria land, colour coded according to frequency of occurrence.





Threats at Hooded Plover locations on Parks Victoria land - Shipwreck Coast

Frequency of vehicle occurance
- Not detected
- Low (<5%)
- Medium (5-20%)
- High (20-50%)
- Very high (>50%)
- Parks Victoria land

Kilometers
0 2 4 8

Threats at Hooded Plover locations on Parks Victoria land - Central

Frequency of vehicle occurance
- Not detected
- Low (<5%)
- Medium (5-20%)
- High (20-50%)
- Very high (>50%)
- Parks Victoria land

Kilometers
0 1.5 3 6

Threats at Hooded Plover locations on Parks Victoria land - South Gippsland

Frequency of vehicle occurance
- Not detected
- Low (<5%)
- Medium (5-20%)
- High (20-50%)
- Very high (>50%)
- Parks Victoria land

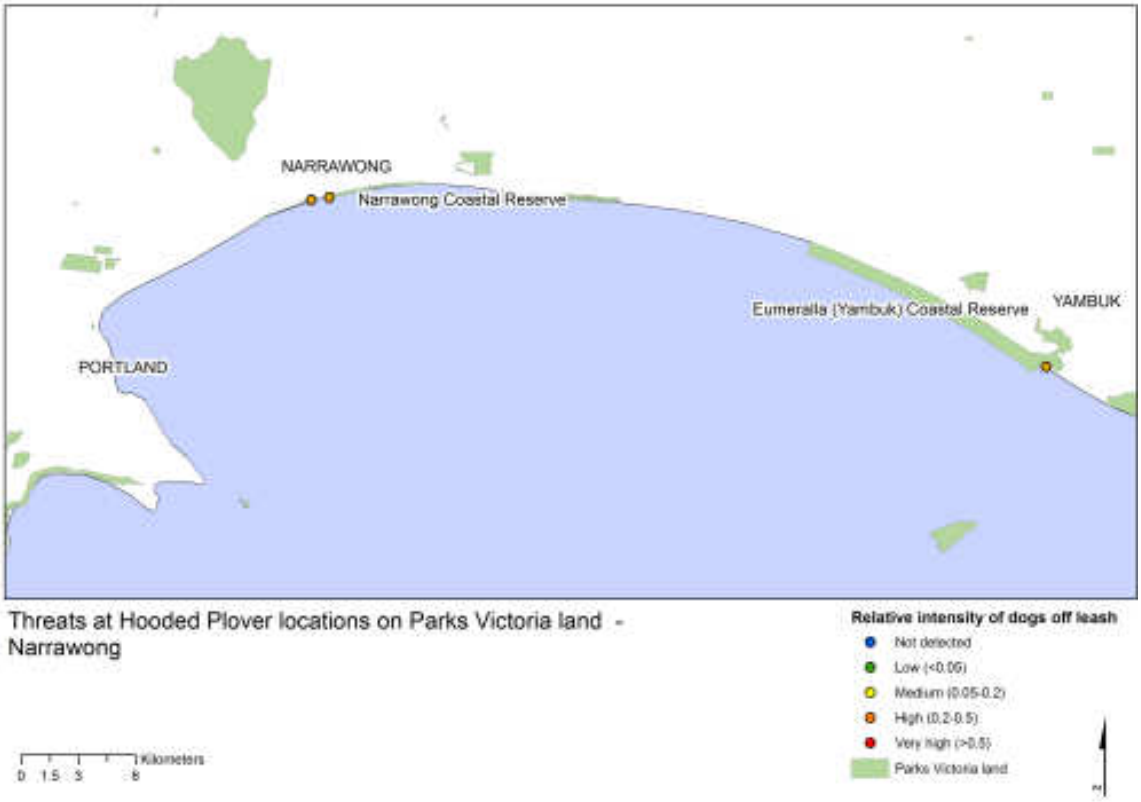
Kilometers
0 2 4 8

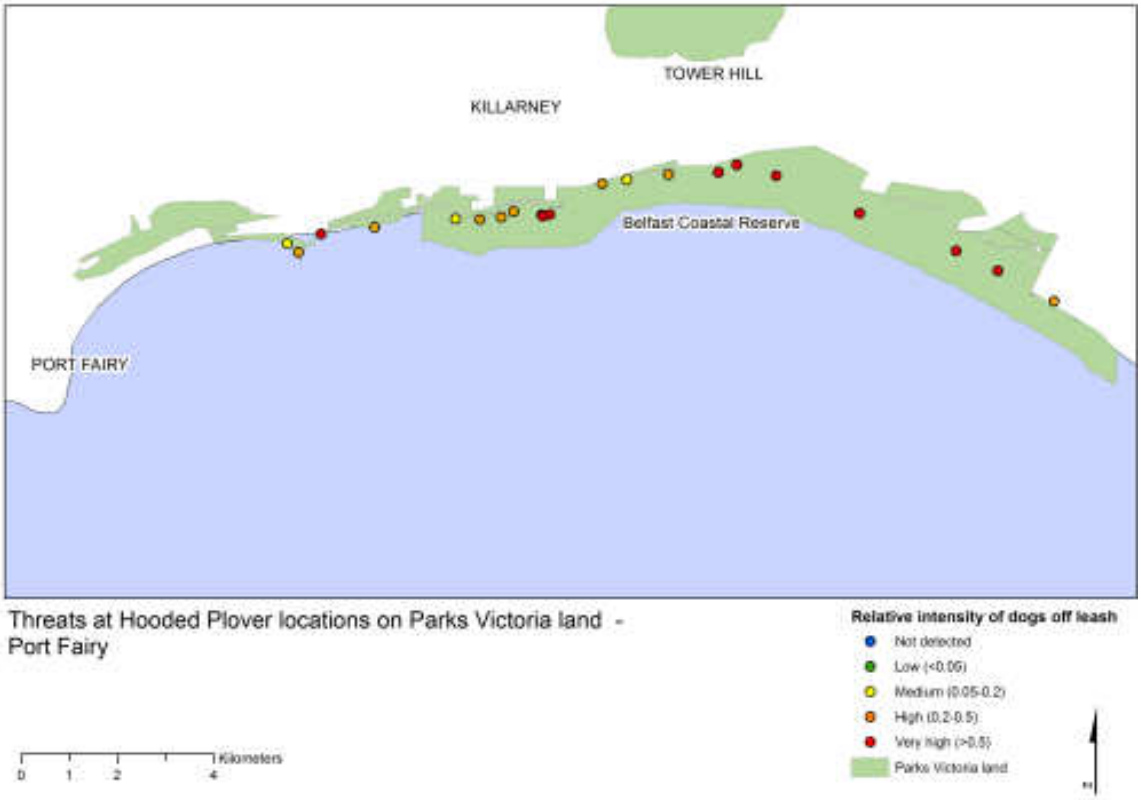
Threats at Hooded Plover locations on Parks Victoria land - East Gippsland

Frequency of vehicle occurance
- Not detected
- Low (<5%)
- Medium (5-20%)
- High (20-50%)
- Very high (>50%)
- Parks Victoria land

Kilometers
0 2 4 8

Figure 13. Dogs off leash recorded at Hooded Plover breeding locations on Parks Victoria land, colour coded according to frequency of occurrence.





Threats at Hooded Plover locations on Parks Victoria land - Shipwreck Coast

Relative intensity of dogs off leash
- Not detected
- Low (<0.05)
- Medium (0.05-0.2)
- High (0.2-0.5)
- Very high (>0.5)
- Parks Victoria land

Kilometers
0 2 4 8

Threats at Hooded Plover locations on Parks Victoria land - Central

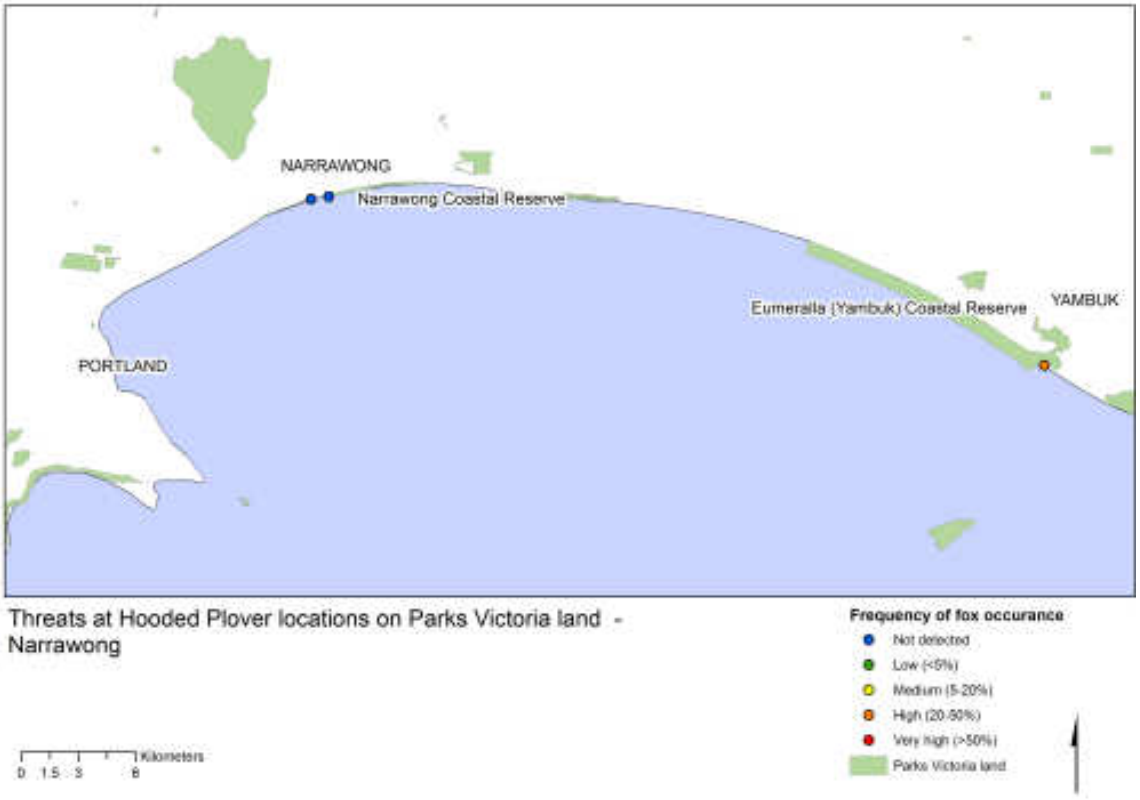
Relative intensity of dogs off leash
- Not detected
- Low (<0.05)
- Medium (0.05-0.2)
- High (0.2-0.5)
- Very high (>0.5)
- Parks Victoria land

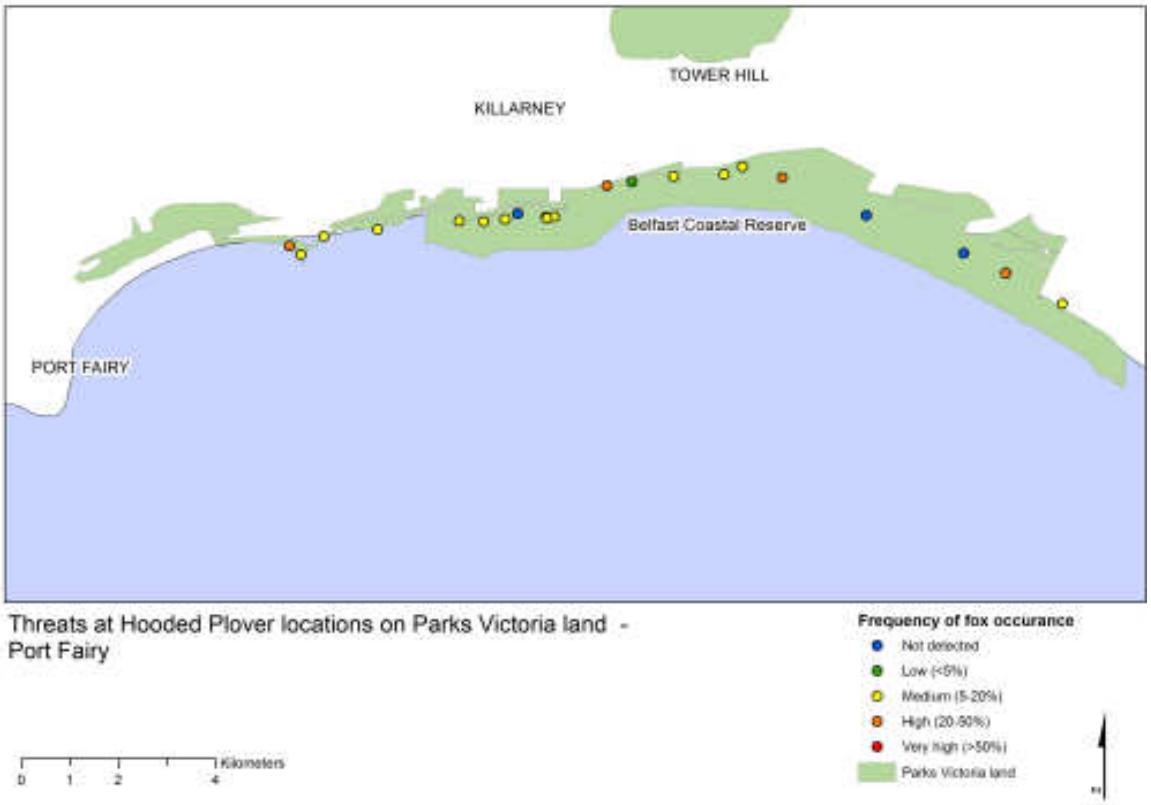
Kilometers
0 1.5 3 6

Threats at Hooded Plover locations on Parks Victoria land - South Gippsland

Threats at Hooded Plover locations on Parks Victoria land - East Gippsland

Figure 14. Foxes recorded at Hooded Plover breeding locations on Parks Victoria land, colour coded according to frequency of occurrence.





Threats at Hooded Plover locations on Parks Victoria land - Shipwreck Coast

Frequency of fox occurance
- Not detected
- Low (<5%)
- Medium (5-20%)
- High (20-50%)
- Very high (>50%)
- Parks Victoria land

Kilometers
0 2 4 8

Threats at Hooded Plover locations on Parks Victoria land - Central

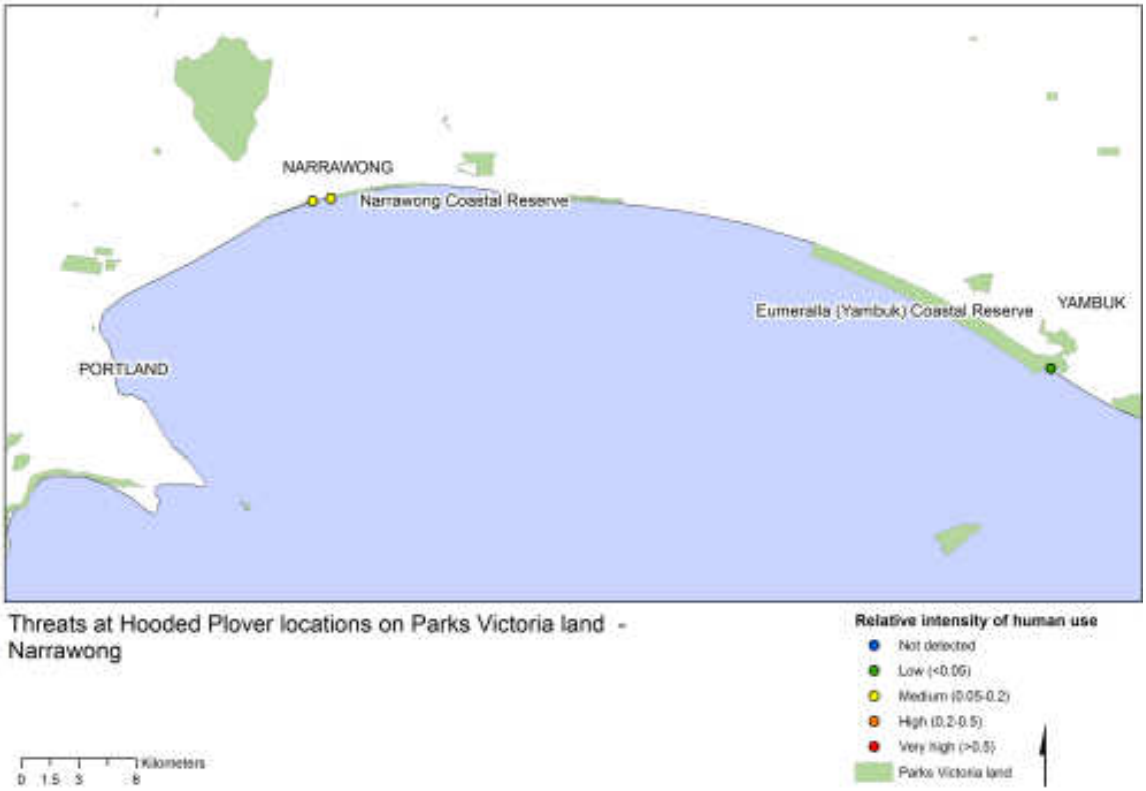
Frequency of fox occurance
- Not detected
- Low (<5%)
- Medium (5-20%)
- High (20-50%)
- Very high (>50%)
- Parks Victoria land

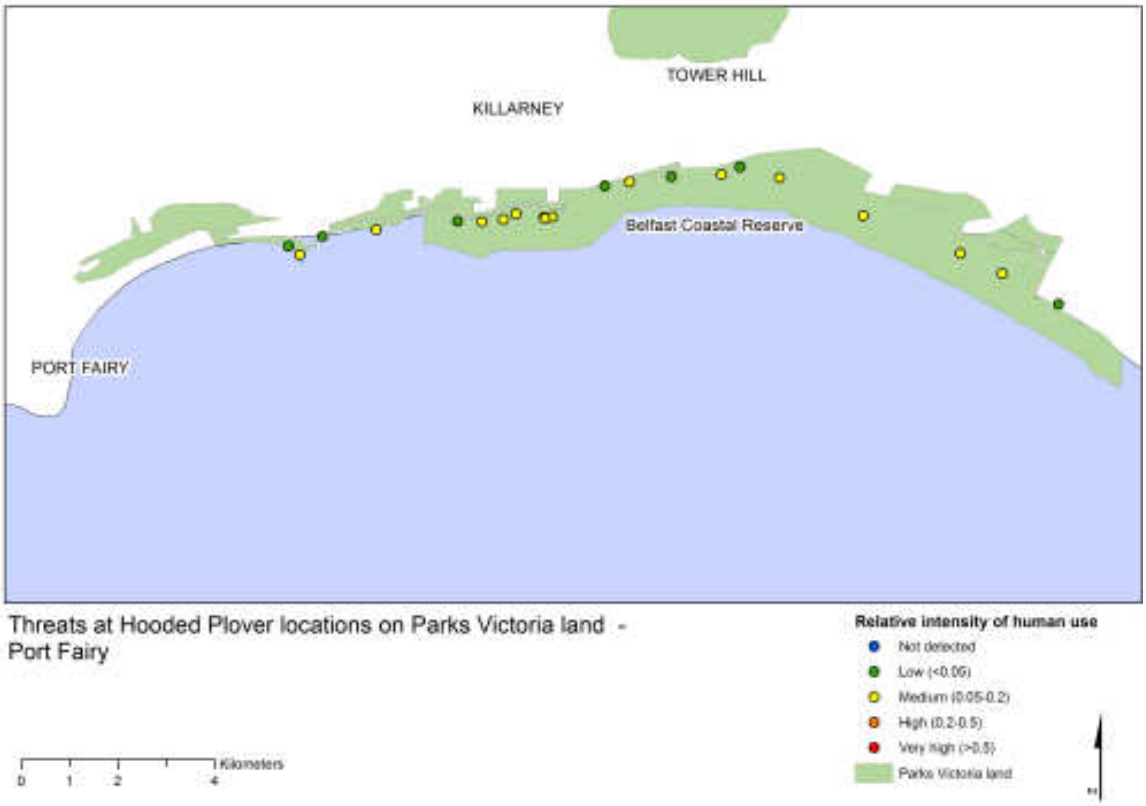
Kilometers
0 1.5 3 6

Threats at Hooded Plover locations on Parks Victoria land - South Gippsland

Threats at Hooded Plover locations on Parks Victoria land - East Gippsland

Figure 15. People (all recreational activities) recorded at Hooded Plover breeding locations on Parks Victoria land, colour coded according to frequency of occurrence.





Threats at Hooded Plover locations on Parks Victoria land - Shipwreck Coast

Relative intensity of human use
Not detected
Low (<0.05)
Medium (0.05-0.2)
High (0.2-0.5)
Very high (>0.5)
Parks Victoria land

Kilometers
0 2 4 8

Threats at Hooded Plover locations on Parks Victoria land - Central

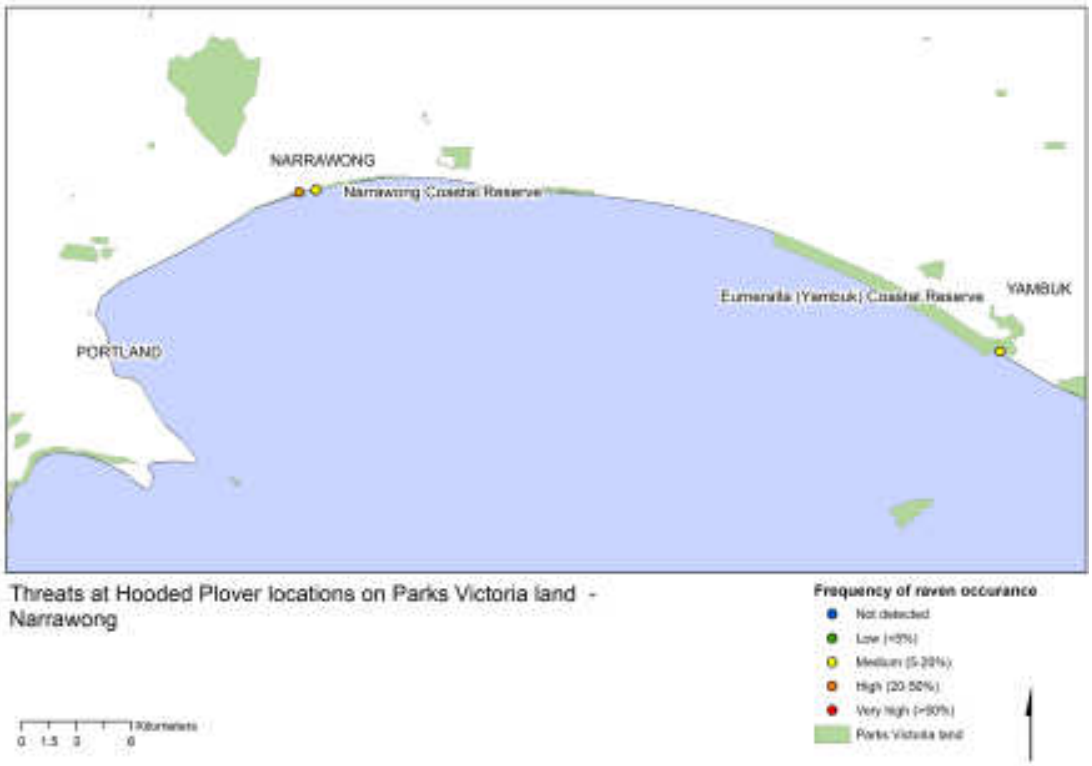
Relative intensity of human use
Not detected
Low (<0.05)
Medium (0.05-0.2)
High (0.2-0.5)
Very high (>0.5)
Parks Victoria land

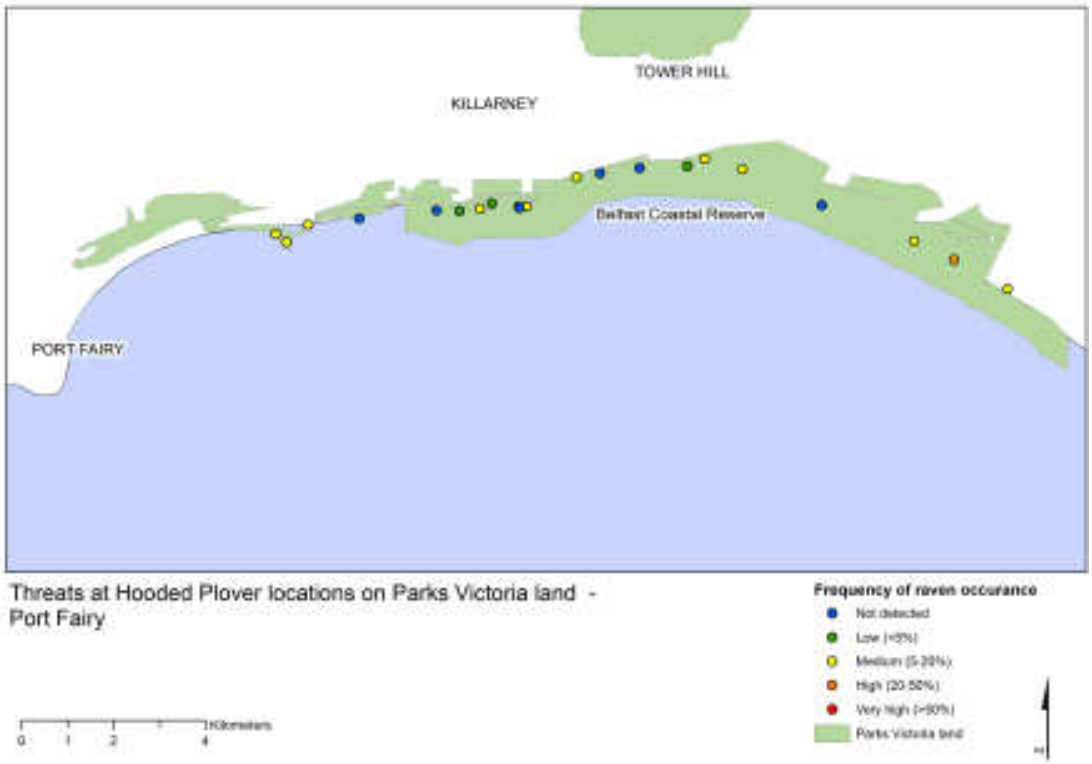
Kilometers
0 1.5 3 6

Threats at Hooded Plover locations on Parks Victoria land - South Gippsland

Threats at Hooded Plover locations on Parks Victoria land - East Gippsland

Figure 16. Ravens recorded at Hooded Plover breeding locations on Parks Victoria land, colour coded according to frequency of occurrence.





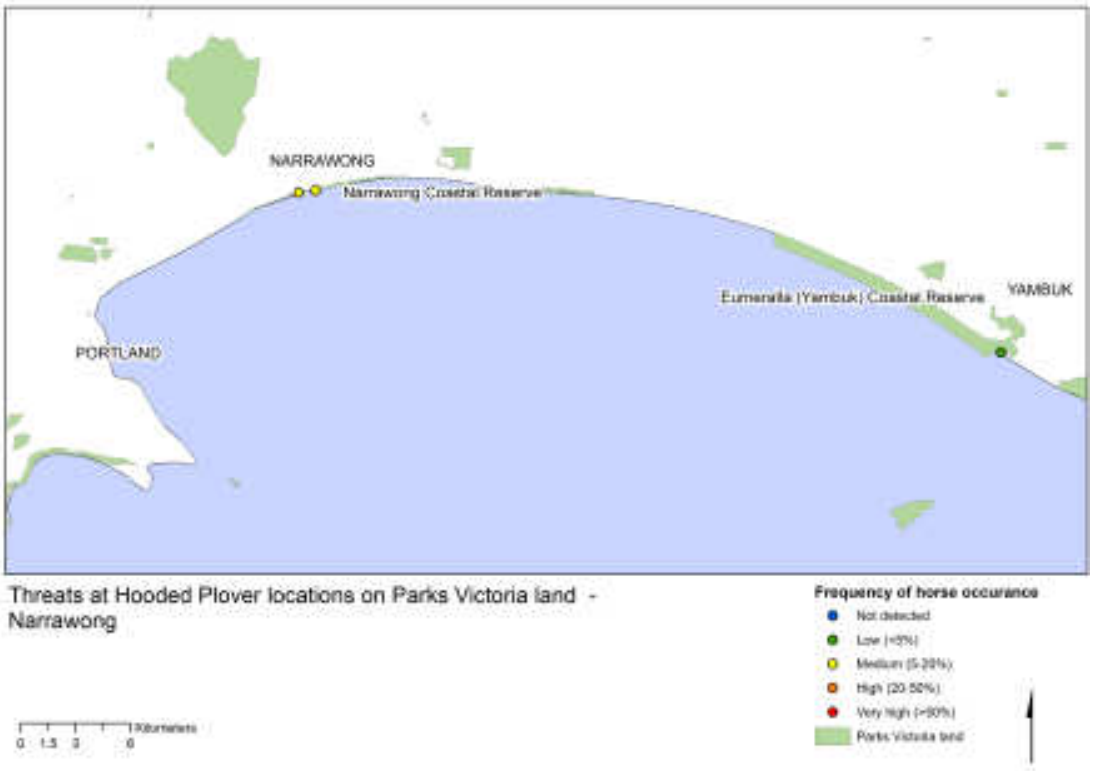
Threats at Hooded Plover locations on Parks Victoria land - Shipwreck Coast

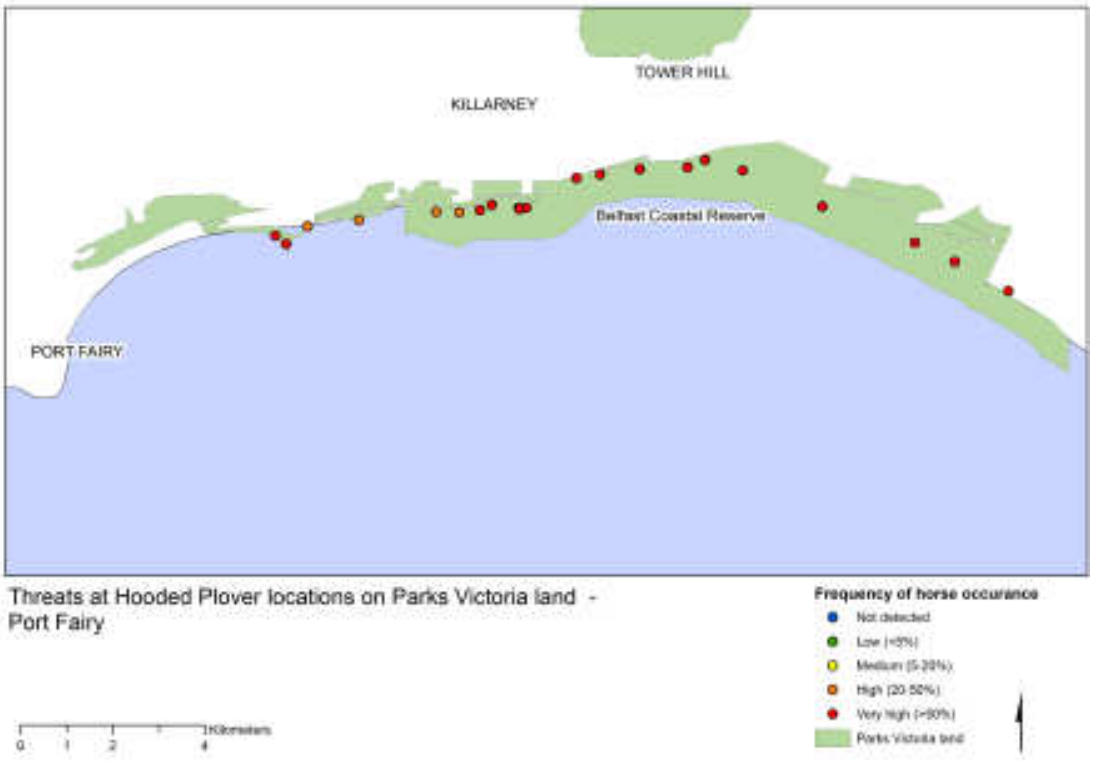
Threats at Hooded Plover locations on Parks Victoria land - Central

Threats at Hooded Plover locations on Parks Victoria land - South Gippsland

Threats at Hooded Plover locations on Parks Victoria land - East Gippsland

Figure 17. Horses recorded at Hooded Plover breeding locations on Parks Victoria land, colour coded according to frequency of occurrence.





Threats at Hooded Plover locations on Parks Victoria land - Shipwreck Coast

Frequency of horse occurance
- Not detected
- Low (<5%)
- Medium (5-20%)
- High (20-50%)
- Very high (>50%)
- Parks Victoria land

Kilometers
0 2 4 8

Threats at Hooded Plover locations on Parks Victoria land - Central

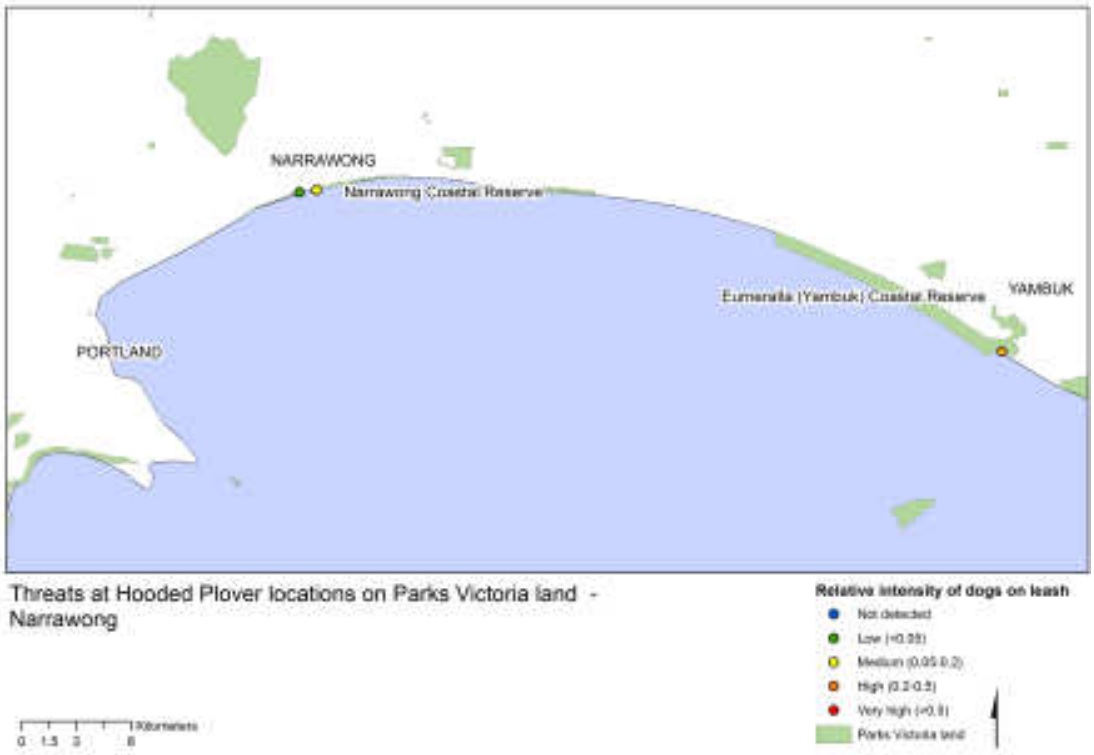
Frequency of horse occurance
- Not detected
- Low (<5%)
- Medium (5-20%)
- High (20-50%)
- Very high (>50%)
- Parks Victoria land

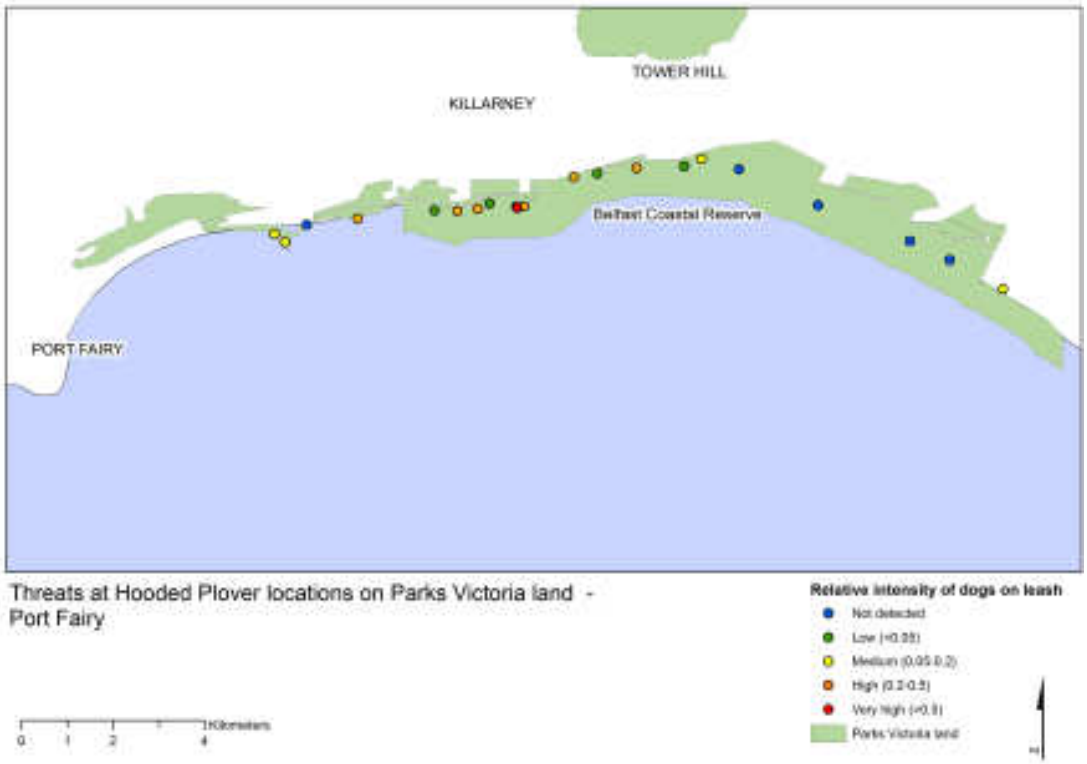
Kilometers
0 1.5 3 6

Threats at Hooded Plover locations on Parks Victoria land - South Gippsland

Threats at Hooded Plover locations on Parks Victoria land - East Gippsland

Figure 18. Dogs on leash recorded at Hooded Plover breeding locations on Parks Victoria land, colour coded according to frequency of occurrence.





Threats at Hooded Plover locations on Parks Victoria land - Shipwreck Coast

Relative intensity of dogs on leash
- Not detected
- Low (<0.05)
- Medium (0.05-0.2)
- High (0.2-0.5)
- Very high (>0.5)
- Parks Victoria land

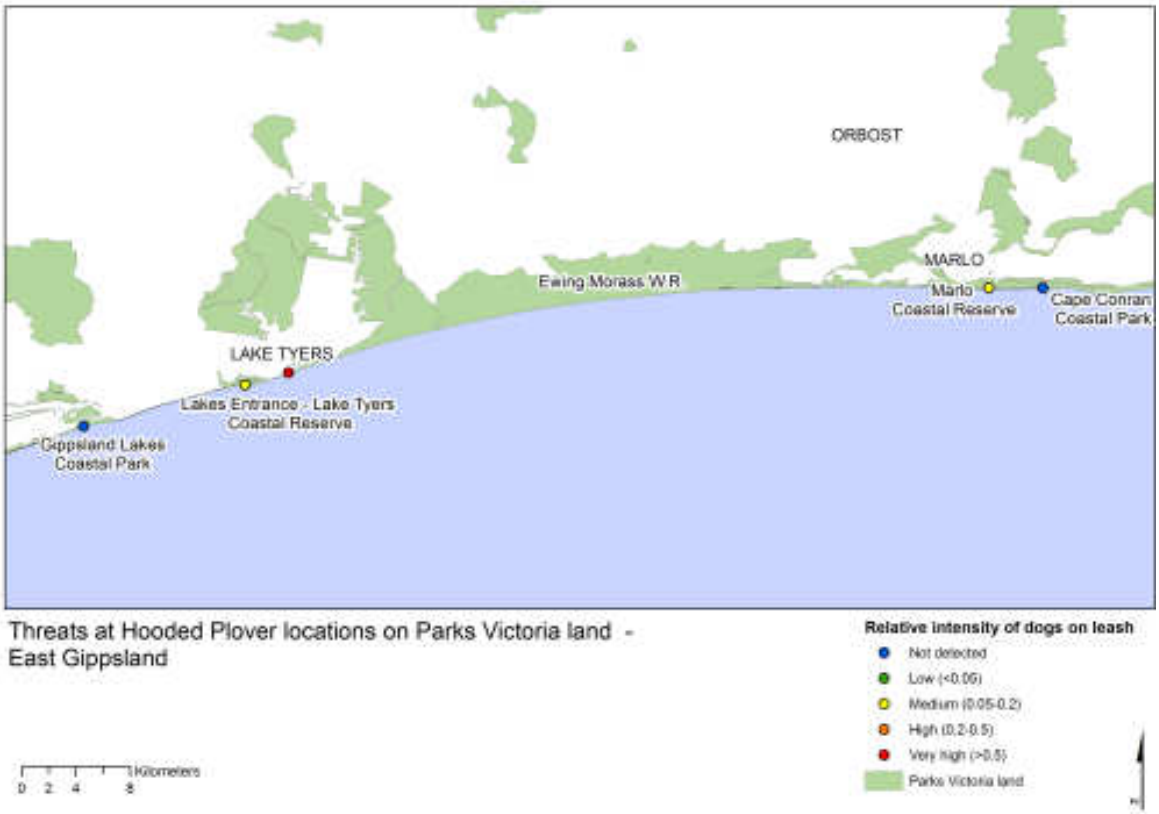
Kilometers
0 2 4 8

Threats at Hooded Plover locations on Parks Victoria land - Central

Relative intensity of dogs on leash
- Not detected
- Low (<0.05)
- Medium (0.05-0.2)
- High (0.2-0.5)
- Very high (>0.5)
- Parks Victoria land

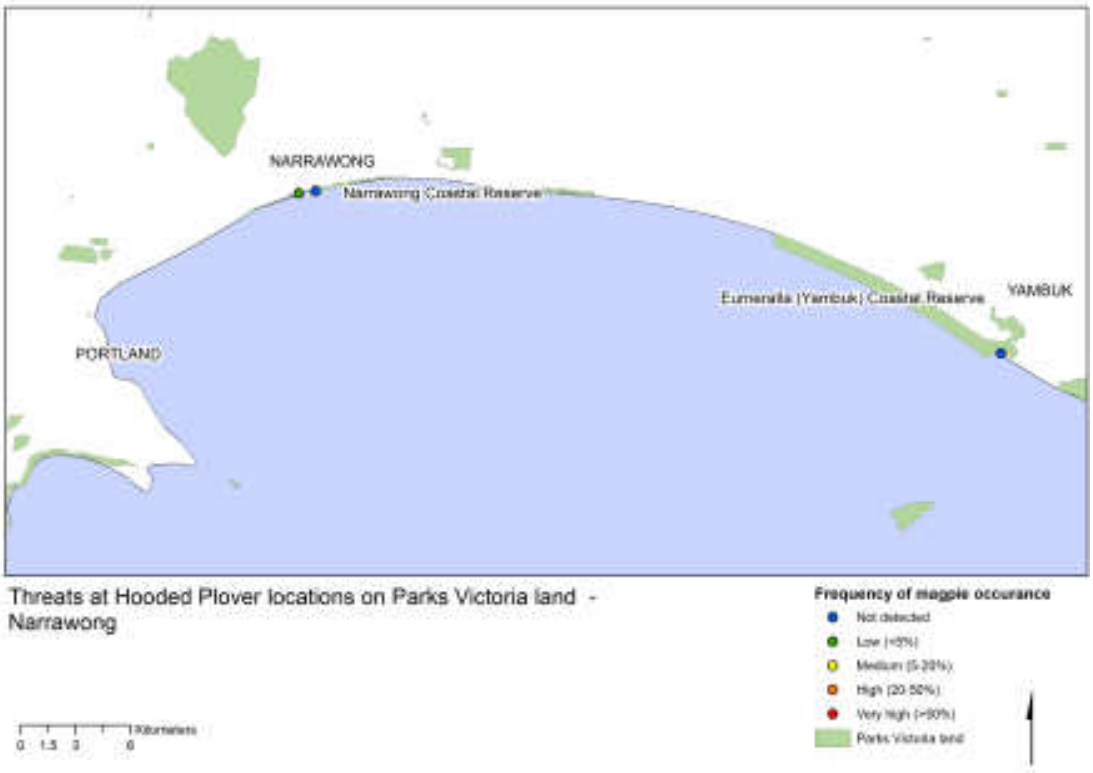
Kilometers
0 1.5 3 6

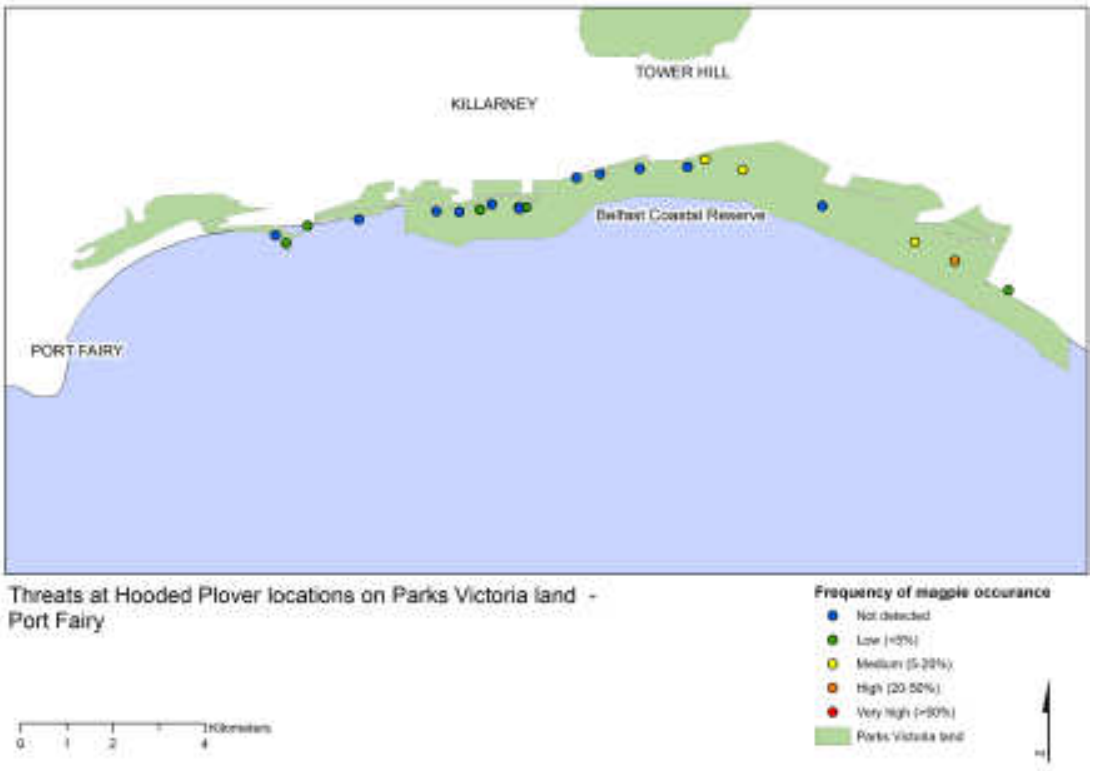
Threats at Hooded Plover locations on Parks Victoria land - South Gippsland



Threats at Hooded Plover locations on Parks Victoria land - East Gippsland

Figure 19. Magpies recorded at Hooded Plover breeding locations on Parks Victoria land, colour coded according to frequency of occurrence.





Threats at Hooded Plover locations on Parks Victoria land - Shipwreck Coast

Frequency of magpie occurance
- Not detected
- Low (<5%)
- Medium (5-20%)
- High (20-50%)
- Very high (>50%)
- Parks Victoria land

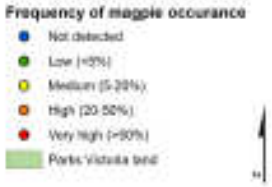
Kilometers
0 2 4 8

Threats at Hooded Plover locations on Parks Victoria land - Central

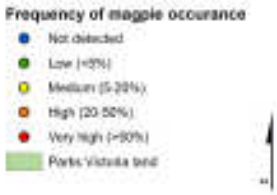
Frequency of magpie occurance
- Not detected
- Low (<5%)
- Medium (5-20%)
- High (20-50%)
- Very high (>50%)
- Parks Victoria land

Kilometers
0 1.5 3 6

Threats at Hooded Plover locations on Parks Victoria land - South Gippsland



Threats at Hooded Plover locations on Parks Victoria land - East Gippsland



Within parks, there can be major differences in the threat index of individual sites. For example, within the Mornington Peninsula, St Andrews beach, Koonya and Rye Number 16 experience greater threat levels than Portsea Franklin Rd and Gunnamatta beach. This can have dramatic impacts on the resultant breeding success of pairs (refer to Chapter 2, Figure 10). Clear trends begin to emerge when the spatial distribution of threats is compared to breeding success. On the Mornington Peninsula, 40% of Hooded Plover pairs in dog free areas produce chicks successfully, compared to just 16% of pairs in dog access areas in the park.

A Multi-Dimensional Scaling (MDS) analysis of threats by sites across the Victorian coast has revealed distinct differences between sites across two dimensional scales: 1) low fox values/high walker values and 2) high dogs off leash, vehicle and horse values (G. Maguire and G. Ehmke unpublished data). There were some regional patterns, where sites in Warrnambool to Portland were the most distinct of any on the Victorian coast, while other sites within regions can be radically different from one another and more similar to sites elsewhere on the coast that have similar access and proximity to major towns/cities, e.g. Portsea and Point Lonsdale are highly similar. The MDS has not revealed any different or additional trends or patterns to our threat index calculations above and so reaffirms our assessment of threats and site variation.

Chapter 4 – Management of Hooded Plovers

Hooded Plovers are widely dispersed along the coast of Victoria. Similarly, those responsible for on-ground management of the species and its habitat are also dispersed. The widespread, low-density distribution of this species represents a challenge for managers, who have limited resources and a multitude of management decisions to make about this species. The following chapter presents management recommendations for the Parks Victoria estate and considers these according to two different scales: 1) landscape scale management and 2) localised site management.

Prioritisation of management investment across the Parks Victoria Estate

Important bird areas are usually calculated according to a threshold of the proportion of the national population supported within an area (page 27). These threshold measures are often used by conservation managers to trigger recognition of the 'value' of an area, or to prioritise conservation investment. This one size fits all approach does not work for species such as the Hooded Plover which are widely dispersed, occur as territorial pairs, and inhabit linear strips of habitat that are sometimes continuous. So how do we define boundaries over which to measure density for the species: by park, or by land reservation status, and are these ecologically meaningful? It becomes evident that prioritisation of sites and regions to invest in is complex. Currently we have limited understanding of barriers to dispersal and thus the importance of maintaining occupancy across the species statewide range.

What is clear is that habitat appears to vary in availability and quality across the coast and there are key regions where investment would benefit a high number of pairs. In many of these areas, this would simultaneously address areas where human-related threats to the species are at their highest intensities (e.g. Mornington Peninsula National Park). Table 17 considers a range of methods for assessing importance of geographic areas as introduced in Chapter 2. While some parks have very low densities of birds, they may act as important flocking sites (e.g. Lonsdale Lakes) or as a habitat link for birds dispersing between two higher density areas (e.g. Bay of Islands Coastal Park), or as both flocking sites and habitat links (e.g. Marlo Coastal Reserve). This signals their value to the population and while these parks may not receive the highest investment of resources, it is important not to discount these sites from at least monitoring attention and some less intensive management strategies to preserve their habitat value (see individual park recommendations on page 153).

Table 17. A range of methods for assessing the importance of parks for Hooded Plovers: 1) the highest density areas on the Eastern Mainland as revealed by the biennial count 2010; 2) parks containing more than 5% of Hooded Plovers occurring on Parks Victoria land; 3) locations meeting Important Bird Area (IBA) criteria (see page 27); 4) important habitat for maintaining dispersal links across the species range (i.e. if this link is lost then the distance between high density areas increases beyond average dispersal distances), and; 5) key flocking sites.

Park name	Biennial count 2010	Greater than 5% of PV pop	IBA	dispersal link	key flocking site
Mornington Peninsula National Park	Y	Y			Y
Belfast Coastal Reserve Coastal Reserve	Y	Y	Y		Y
Kilcunda - Harmers Haven Coastal Reserve	Y	Y			Y
Cape Liptrap Coastal Park		Y			Y
Discovery Bay Coastal Park		Y	Y		
Croajingolong National Park		Y		Y	
Great Otway National Park		Y			Y
Wilsons Promontory National Park		Y			Y
Nooramunga Marine & Coastal Park			Y		
Yambuk F.F.R.	Y		Y		
Eumeralla (Yambuk) Coastal Reserve	Y		Y		Y
Narrawong Coastal Reserve	Y		Y		
Lonsdale Lakes W.R					Y
Bay Of Islands Coastal Park				Y	
Port Campbell National Park				Y	
Eagle Rock Marine Sanctuary				Y	
Shallow Inlet Marine & Coastal Park					Y
Mcloughlins Beach - Seaspray Coastal Reserve				Y	
Gippsland Lakes Coastal Park				Y	
Marlo Coastal Reserve				Y	Y
Cape Conran Coastal Park				Y	

Additional parks which did not fall under any of the above categories include: Point Nepean National Park, Bunurong Coastal Reserve, Punchbowl Coastal Reserve, Lakes Entrance – Lake Tyers Coastal Reserve, Elliot River – Addis Bay Coastal Reserve, Port Phillip Heads Marine National Park and Ewing Morass W. R.

If the approach of concentrating management investment on the regions with the highest densities of Hooded Plovers was taken, this would result in three major regions of investment: Discovery Bay to Warrnambool in the far west (blue shading Table 17), the Mornington Peninsula on the central coast (grey shading Table 17), and the Bass Coast to Wilsons Prom in the east (orange shading Table 17). Such a concentration of management would neglect large sections of coast that are important to linking populations, such as the coast between East of Wilsons Promontory and New South Wales, where the species range has already dramatically declined. Furthermore, there would be a major gap between the central coast and west coast of the species Victorian distribution.

If management investment further extended to include the two additional parks (Great Otways and Croajingalong National Parks) with at least 5% of the Parks Victoria Hooded Plover population, then this would partly resolve the dispersal issues associated with the above prioritisation process, however, there would still remain gaps of 290 km (between Wilsons Prom and Croajingalong) and 65 km (between Belfast Coastal Reserve and Great Otway National Park), which we know to exceed the average dispersal distances exhibited by Hooded Plovers (Weston *et al.* 2009).

It is therefore critical to consider the population as a whole and to recognise that dispersal of the population across its breeding range serves as a hedge against catastrophes (for example oil spills, storm events or disease) which might depress regional survival and/or productivity. Maintaining robust, well-distributed subpopulations should reduce variance in survival and productivity of the population as a whole, facilitate interchange of genetic material between subpopulations, and promote recolonisation of any sites that experience declines or local extinctions due to low productivity and/or temporary habitat changes. In other words, it is unwise to put all eggs in the one basket.

Management decisions come down to a combination of the following criteria:

- The source of the threat: the aim is to manage human-related threats, not to invest in managing threats which are natural;
- The intensity of human visitation: it is evident that there is strong variation across sites even within the one park, the most highly threatened sites need to be prioritized in order to mitigate the extreme human-related pressure these breeding pairs are facing;
- Volunteer assistance: volunteers increase the capacity to monitor pairs and therefore, nests are more likely to be discovered and their location relayed to managers. Volunteers across many parts of Victoria are also trained to carry out site specific nest protection (e.g. fencing and signing of nests) and can help ease the workload of land managers.

Detailed management prescriptions

Table 18 provides an overview of the range of Hooded Plover on-ground managements available and relates these to each threat type. Maguire (2008) provides detailed prescriptions for each management option available for mitigating human-related threats to Hooded Plovers. This includes:

- Flowcharts related to site morphology and the decision making process for deciding whether a nest needs to be managed and to what degree based on whether it is situated in the dune, on the beach, or by an estuary. As a general rule, dune nests are typically less likely to require localised protection, while beach and estuary nests are at greater risk of crushing and disturbance. There are of course exceptions to this rule that the flowcharts consider, namely the type of recreational use and proximity to access play a major role here.
- Materials required and size dimensions, e.g. the dimensions of chick shelters, size of protective nest site fencing, distance of sign placement, recommended materials for fencing. These are strongly linked to the effectiveness of the management and to reducing any potential risks that management intervention might pose, e.g. birds may abandon the nest if the wrong material is used for fencing.
- Instructions for implementing managements, e.g. time limits for erecting fencing, configuration of fencing and signage.
- Discussion of the pros and cons of particular managements, such as weed removal options, fox control options, predator exclusion.

Table 18. Summary of threats and corresponding management options.

	Signs – permanent	Signs - notices	Signs – flanking	Bollards and gates	Fences - access	Fences - dunes	Fences – temp rope	Fences – temp mesh	Site / access closures	Chick shelters	Weed control	Habitat -modify	Nest relocation	Predator control	Predator training	Predator exclusion	Coastal planning	Policy changes	Regulation enforcement	Wardening	Educational materials	Emergency response
Coastal development									√								√	√	√		√	
Oil spills																						√
Vehicles	√	√	√	√	√	√	√	√	√	?								√	√		√	
Marram Grass											√	√						√				
Dogs off leash	√	√	√		√	√	√	√	√	√								√	√	√	√	
Static People	√	√	√				√	√	√											√	√	
Foxes														√	√	√						
Ravens										√				√	√	√						
Horses	√	√	√		√	√	√	√	√	√								√	√	√	√	
Stock						√		√		√											√	
Deer						√		√		√								√				
Cats														√		√		√			√	
Sea Spurge											√											
Sea wheat grass											√											

	Signs – permanent	Signs - notices	Signs – flanking	Bollards and gates	Fences - access	Fences - dunes	Fences – temp rope	Fences – temp mesh	Site / access closures	Chick shelters	Weed control	Habitat -modify	Nest relocation	Predator control	Predator training	Predator exclusion	Coastal planning	Policy changes	Regulation enforcement	Wardening	Educational materials	Emergency response
Dune stabilisation												√					√				√	
Mobile People	√	√	√		√	√	√	√	√	√										√	√	
Dogs on leash	√	√	√		√		√	√	√	√								√	√	√	√	
Gulls										√				√		√						
Magpies																						
Litter																					√	√
Driftwood removal																			√		√	
Rats														√								
Aircraft										√								√			√	
Boats		√	√				√	√	√	√											√	
Rising sea levels												√	√									

Scale of investment

Chapter 3 has revealed that there is strong spatial variation in threats breeding Hooded Plovers experience. Some of these threats are able to be addressed at a broad (landscape) spatial scale and others have a more localised impact, e.g. they impact the breeding site. Landscape scale management solutions are preferred by land managers as they are considered most resource efficient, e.g. a single investment that can benefit multiple pairs simultaneously. The reality of managing a species that is subject to multiple threats, many of which primarily impact the nest or chicks, is that landscape scale solutions are often not enough to translate into improved breeding success for pairs at the site level. Instead, management at the breeding site of a single pair or nest can result in a direct positive outcome and when carried out for 'enough' pairs, can significantly improve breeding success at the population level.

Current fledging rates are the result of considerable (but highly localised) management investment across the Victorian coast (see Figures 20 to 22): close to fifty percent of fledglings produced by approximately half of Victoria's population of Hooded Plovers came from highly threatened beach sites where management occurred at the breeding site level. If the population relied on the breeding success of pairs in isolated or inaccessible sites, then fecundity would only be half of what was achieved with management. This would double current calculations from a 22% to a 44% Hooded Plover population decline within 10 years. This creates strong justification for investing at the site level.

Figure 20. Map of the distribution of management investment at nest sites over five breeding seasons on west coast of Victoria.

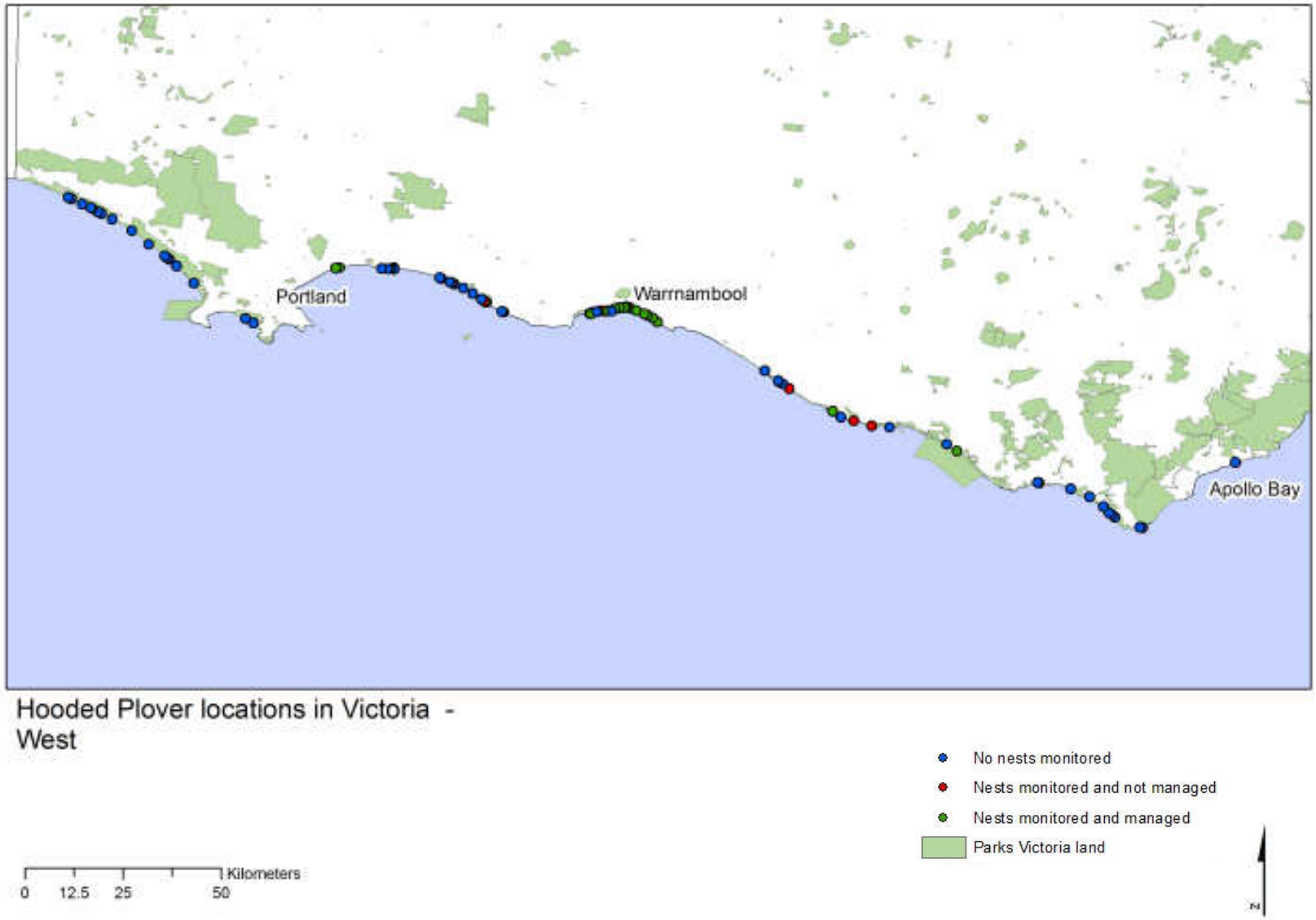
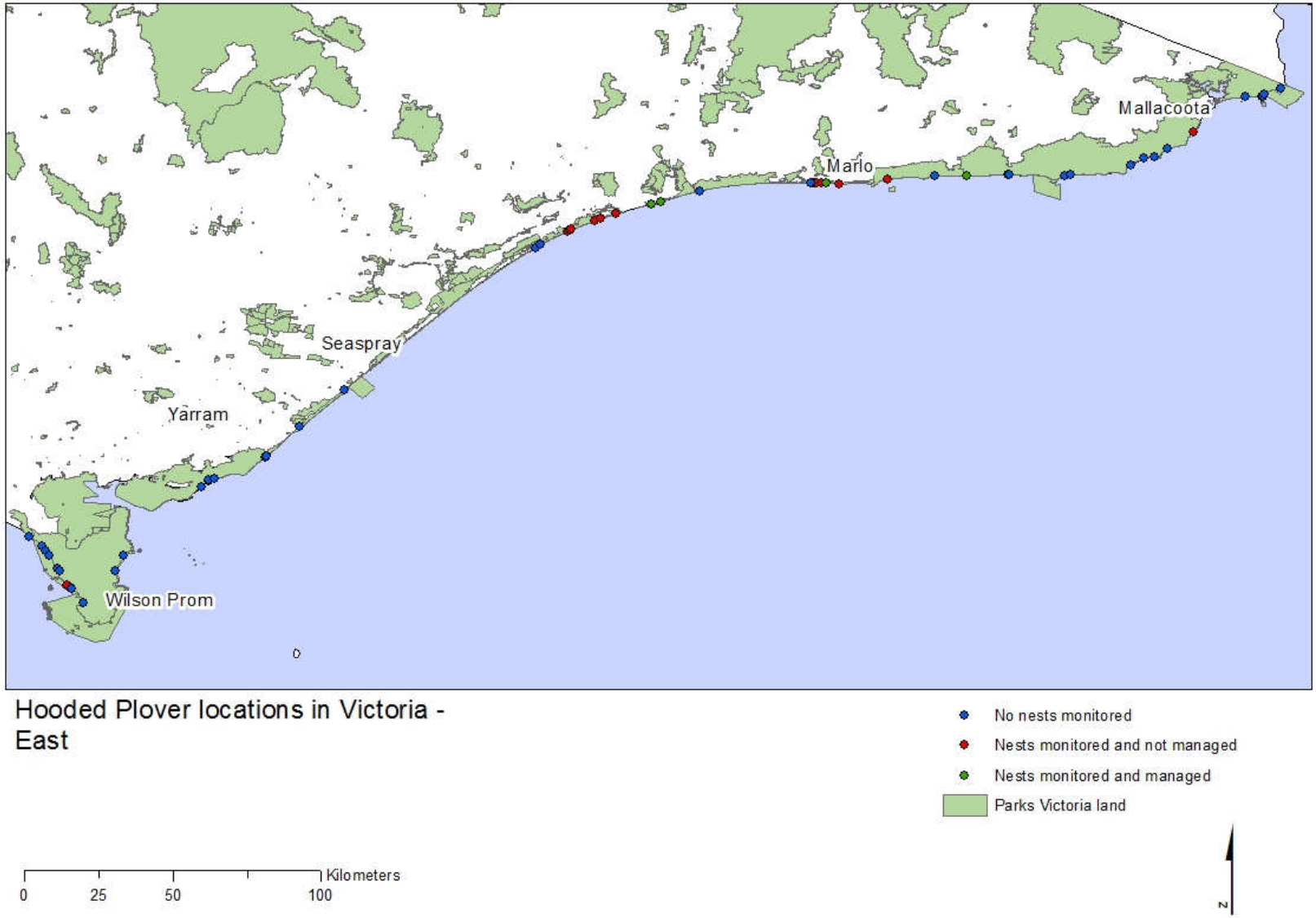


Figure 21. Map of the distribution of management investment at nest sites over five breeding seasons on central coast of Victoria.

Figure 22. Map of the distribution of management investment at nest sites over five breeding seasons on east coast of Victoria.



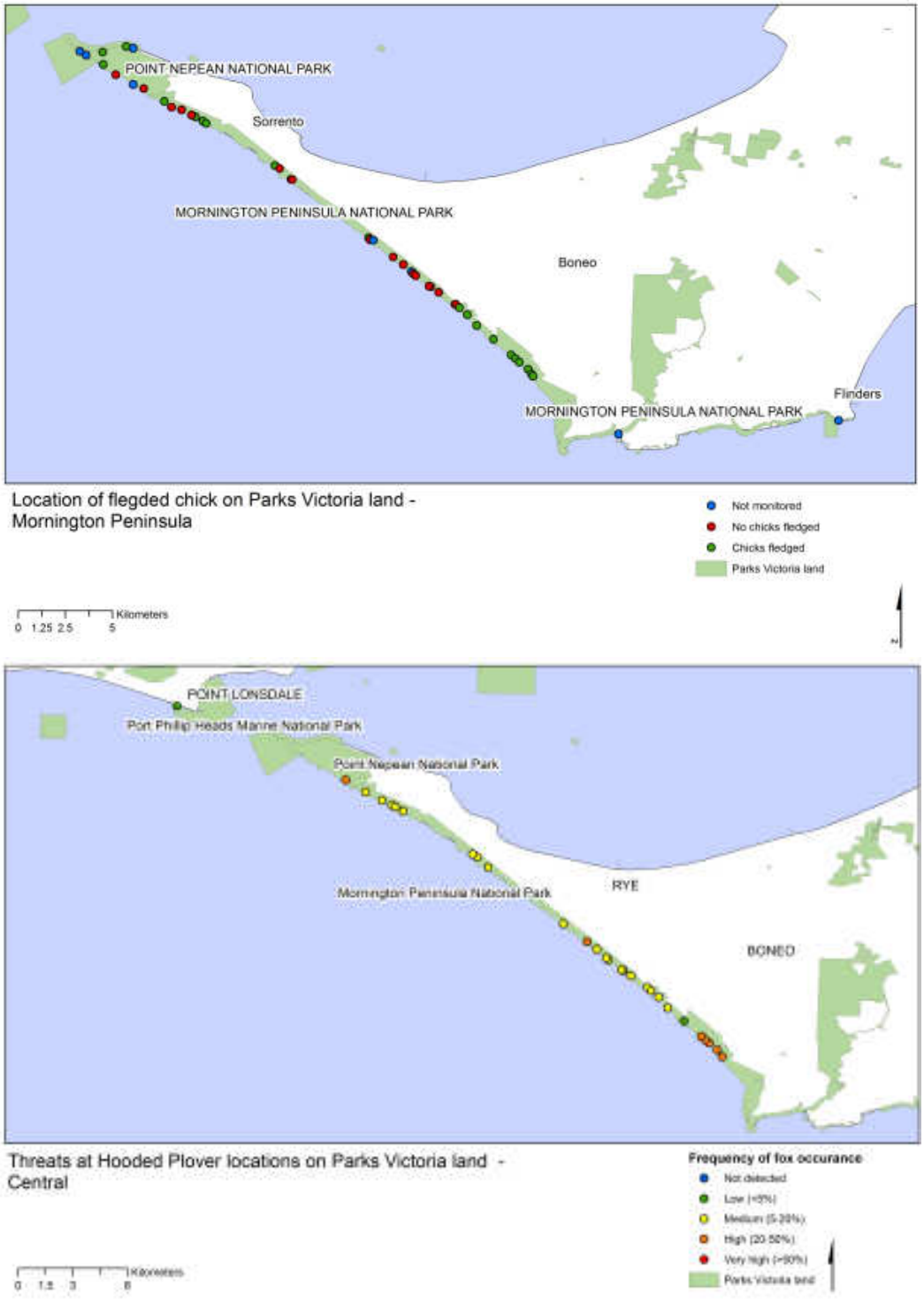
Landscape scale management options

There are several threats which can be managed at the landscape scale to benefit multiple pairs. These also value add to localised management efforts. These include predator control, weed control, and sympathetic policies/planning considerations including reviewing land reservation status and effectiveness of current regulations, as well as education to bring about sustainable beach use by recreationists.

Predator control

Maguire (2008) provides detailed reviews of fox, cat and avian predator control. The benefits of landscape scale fox control to small mammals and ground nesting birds are highly apparent from successful programs such as Southern Ark (DSE 2003). In order for the benefits to transfer to Hooded Plovers, programs such as these need to encompass the foreshore environment. It becomes less clear as to the benefits of fox baiting across smaller areas or along foreshore strips if the adjacent hinterland is not also baited. Here proximity to a source population of foxes will result in foxes continuing to fill vacant territories which arise along the foreshore, thus not addressing the problem in the long-term. It is interesting to note that foxes do not appear to inhibit successful breeding of Hooded Plovers (Figure 23). Although in these areas fox baiting is carried out to some degree throughout the year.

Figure 23. Above is a map of sites on the Mornington Peninsula successfully producing chicks in five breeding seasons from 2006 onward. Below is a map of the frequency of occurrence of foxes at those sites. Hooded Plovers are most successful in the southern and northern ends of the park, which is also where fox occurrence is highest.



Avian predator control is less clear. Mead (2012) was the first to identify ravens and magpies as major egg predators. There have been no attempts to date to control the impacts of avian predators in Victoria. Some broad scale solutions may include litter management or reducing breeding efficiency of silver gull colonies (e.g. egg oiling), in NSW, problematic silver gulls and ravens are lethally controlled to protect Hooded Plover nesting sites at a localised scale.

Training of intelligent predators using conditioned taste aversion has been explored to train foxes to cease taking Hooded Plover eggs (see Appendix 1). This was ineffective when trialled across the Victorian coast as it was non-target selective. Predator exclosures (i.e. nest cages) are an option discussed in Maguire (2008), but currently nest cages are not a recommended option given the high risks of adult mortality associated with this technique.

Weed control

Maguire (2008) provides detailed reviews of weed control methods for Marram Grass, Sea Spurge and Sea Wheat-grass. In some areas of the coast, particularly far west Victoria, weed invasions of the dunes (primarily by Marram Grass) are majorly limiting nesting habitat availability where birds only have a narrow strip of upper beach available for nesting. This coupled with storm surges and rising sea levels can result in high nest losses to tidal inundation and in some seasons has crippled breeding success in that area. Where weed invasions are making dune and foredune habitats unavailable for nesting, action is required to improve habitat and return resilience to the dune ecosystem. This is a priority as it will impact the effectiveness of all other managements at the site, providing more space for recreation and nesting to co-occur on the beach.

Land Reservation Status and a statewide regulatory framework

Four of the parks (Belfast Coastal Reserve, Kilcunda-Harmers Haven Coastal Reserve, Eumeralla (Yambuk) Coastal Reserve and Narrawong Coastal Reserve) ranked in the top ten as containing the bulk of Hooded Plovers on the Parks Victoria Estate (Table 4) do not have regulations in place to assist with mitigating the impacts of human-based recreation (e.g. dog walking, horse riding, etc) due to their land reservation status as coastal reserves. To put this in perspective, 36% of the Parks Victoria Estate containing 27% of the Victorian population does not have regulations, which are undoubtedly the keystone for managing human recreation and associated threats to the Hooded Plover.

These four parks are each identified as high priority areas for management attention in Chapter 4. If Appendix 7 is consulted, which presents Hooded Plover breeding sites (for which we have data) from most highly threatened to least threatened, sites occurring within coastal reserves commonly rank as the most highly threatened sites on the Parks

Victoria Estate with an average weighted threat index value of 55.2, compared to 37.6 for sites occurring within National and Coastal Parks. This suggests that the regulatory structure offered by a higher land reservation status is of high value to reducing threats experienced by Hooded Plovers. There are some exceptions to the effectiveness of higher land reservation status, whereby several sites within Cape Liptrap Coastal Park, Mornington Peninsula National Park and Bay of Islands Coastal Park experience high threat indices. This primarily relates to the intensity of visitation at sites and is a reminder of the need for visitor management and enforcement of regulations at sites receiving high levels of human use.

Increasing the land reservation status of key parks may be one means of introducing a regulatory framework for managing human access to these high value habitat areas. An alternative, which may also have benefits for sites across the Victorian coast outside of the Parks Victoria Estate, would be to establish a statewide regulatory framework that consistently mitigates human-related impacts at Hooded Plover breeding sites. This would need to be investigated with the Department of Primary Industries and Environment (DEPI). Through the Flora and Fauna Guarantee Act 1988 there is the capacity to determine Critical Habitat and implement an Interim Conservation Order which may provide for all or any of the following:

(a) the conservation protection or management of flora, fauna, land or water within the critical habitat which is the subject of the order;

(b) the prohibition or *regulation* of any activity or process which takes place on the land or in relation to the water or the use, management or development of the land or water within the critical habitat which is the subject of the order;

(c) the prohibition, *regulation* or management of any activity or process which takes place outside the critical habitat which is the subject of the order but which is likely to adversely affect the critical habitat;

(d) a requirement to undertake works or activities specified in the order or by the Secretary.

Declaration of Critical Habitat is solely at the discretion of the Secretary. The Flora and Fauna Act 1988 does not contain any legislative criteria or guidelines as to when a Critical Habitat Determination (CHD) should be made. Thus considerable discussions and cooperation between DEPI, Parks Victoria and land managers across the state would be critical to this process, as well as considerable public support.

Vehicle access protocols

Vehicles can impact multiple pairs in a single drive along a beach. The following steps are recommended for mitigating the risks of driving on beaches and should be followed by all legal users including rangers, contractors and researchers:

- Vehicle users should be made aware of the threats to Hooded Plovers and if possible, of the current nesting situation of pairs, so as to exercise extreme caution when traversing the area.
- Access to the site is via designated tracks and pathways only.
- It is most critical that the beach is not accessed in the period one hour either side of high tide. Access should only occur at times of low or medium tide where there is enough room for the vehicle or machinery to move along the beach and keep below the high-tide mark. Consideration must be given to how many hours the vehicle will be out on the beach, leaving enough time to return along the beach before the tide has risen.
- All machinery, vehicles and equipment are driven along the water's edge to minimize the likelihood of crushing flightless chicks and disturbing nesting birds and chicks.
- All machinery, vehicles and equipment are driven at low speeds (~25 km/h).
- Drivers slow down further when passing signed nesting areas.
- Night driving and driving in poor weather or low light conditions should be avoided where possible. In conditions of poor visibility, speeds must be further reduced and extreme caution exercised.

Horse access management strategy

Horse riding is viewed as a high threat recreational activity impacting the breeding success of Hooded Plovers. There is currently no statewide database of horse access on the Parks Victoria estate available. This is a limitation to effective management and education of horse riders, and it is recommended that better planning/implementation be applied. Below are recommendations for mitigating impacts of horse access on the Parks Victoria estate:

- Thresholds need to be considered. On the Belfast coast, a commercial group (Rundell's Mahogany Trail rides) use the Warrnambool Levy's stretch of beach; and the Warrnambool Horse Riders Trail Club formally sought access to a series of trails for club events in 2012. This is in addition to horse trainers and local recreation groups and individual riders already using this coastline. The risks to Hooded Plovers become cumulative and unmanageable once too many horses access the coast. With no regulations or permit system in place, it becomes difficult to mitigate this threat.
- A consistent approach to horse access is required across the Victorian coast and this could be implemented via a permit system. This creates a means to educate horse riders and to mitigate threats to breeding Hooded Plovers. This also allows for an informed consideration of a threshold to access. Permits need not cost

anything and they serve as an effective means of understanding the degree of use of the beaches by this user group, and of delivering information. Initiating a permit system in the Belfast Coastal Reserve would align this coastal reserve with areas elsewhere in Victoria such as the Kilcunda - Harmers Haven Coastal Reserve in South Gippsland, where all horse riders must obtain a permit and complete an induction.

- Prohibiting access to narrow beaches, particularly where the coast changes orientation and rounds corners. These beaches have a morphology which does not afford space for horses and birds to coexist. An example of a coastline that is unsuitable for horse access is that between Mills Reef and The Basin within the Belfast Coastal Reserve, where the dune system is weed infested and the beach is narrow and frequently curves. An example of coastline which is more suitable to horse access is Kilcunda beach where the coast is linear, the beach wide and the dune system highly accessible for the birds.
- Horse access must be subject to review every two years, and impacts and new research taken into consideration.
- Rides within the breeding season should be under the below set of conditions:

    - Rides on the beach should not be permitted where temperatures are forecasted to exceed 35 ° C and/or winds to exceed 49 km/h[2].
    - Horse riding is only permitted at times of low tide so that the condition of riding below the high-tide mark is able to be withheld. Riding must not occur within one hour either side of high tide.
    - When riders see a signed and fenced nesting area on the beach, they must slow to walking pace until they have passed the area (100 metres either side).
    - When accessing a beach via a formal track that enters an estuary, horses should move slowly and in a direct line down to the edge of the sea.
    - Riders must be aware of the impacts to Hooded Plovers and group leaders must complete an induction[3].
    - For group rides:
    - group size capped at 15 and a maximum of 30 riders to use a given 'trail'. The two groups of up to 15 riders should be separated in time by at least 40 minutes[4].

[2] At high temperatures and/or near gale/gale force winds, if the bird is disturbed off the nest for more than 5-10 minutes there is a high likelihood of nest failure due to eggs reaching thermal extremes (sand temperatures (which are typically higher than ambient temperatures) of 43 ° C are lethal to embryos within the egg) or being rapidly buried by wind cast sand.

[3] BirdLife Australia developed an induction for horse riders for Parks Victoria to provide to Rundell's Mahogany Trail Rides. The induction is relatively detailed, however, we kept this as brief as possible and used a lot of photos to simplify the material. It should not take a layperson more than half an hour to complete. Ranger Brian Martin (Parks Victoria Wonthaggi) gives this induction to all horse riders seeking a permit for access to Kilcunda - Harmers Haven Coastal Reserve and before he issues a permit asks them to complete the accompanying multiple choice test. We strongly recommend circulating this induction kit (and associated materials) amongst all horse riders that use the coastal reserve between Warrnambool and Port Fairy.

[4] This is taking into account that the group will move through in single file and so a group of 15 horses will be seen from a distance by the birds, they will come off the nest and wait for each horse to pass and be distant enough from the nest before they return. This could amount to over 30 minutes off the nest. It is vital they

- riders must go in single file along the water's edge.
- for organised events, at least one week's notification of the intended visit so that current nesting information can be assessed and specifics about locations of active nests and chicks passed on to the group. If there are chicks of less than two weeks old on a given trail, recommend use of an alternative trail for use that visit.

- At any time of year, there should be no riding in or along the dunes as this will erode these sensitive systems; only formal paths should be used to access the beach.
- At any time of year, dogs should not be permitted to accompany horse riders.

Dog access management strategy

Dog access is one of the more difficult areas of management for conserving Hooded Plovers due to the need for an integrated approach across multiple agencies, high levels of resources to implement and enforce regulations, and polarised views often present within local communities.

There is a high reliance on public open spaces for dog walking. Often dog access zoning is formulated so as to balance the needs of recreational users, for example, providing dog free areas on beaches popular with families and/or for swimming, and allocating dog access to beaches that are less heavily used. The latter are often beaches which offer better habitat for wildlife. Historical decision making has often overlooked the conflict between dog access and the requirements of threatened species such as the Hooded Plover. In this report and other research papers (Williams *et al.* 2009; Schneider 2013), it has been highlighted that compliance with dog leashing is incredibly poor and most dogs accessing Hooded Plover breeding sites are off leash. Furthermore, dogs off leash can be as much an issue for breeding birds on beaches within a coastal reserve as within a national park, highlighting that land reservation status and current regulations are not effectively mitigating this threat type (also see Schneider 2013).

Changes to or introduction of dog regulations can be met with public outcry from local dog walkers, and it is important that consistent steps be taken when reviewing whether change is warranted and how to tackle this change. More damage can be done than good by implementing major changes to access with limited public consultation and where there has been no prior investment in education or trying to improve compliance.

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have at least a degree of time back on the nest before the next group comes through. The larger the group, the longer it takes to have riders pass by and so we have capped a group at 15 to account for this.

Steps to reviewing dog access and improving compliance

1) Overlaying current dog regulations, where they exist, against the distribution of breeding pairs: are pairs sufficiently protected within their range? As a minimum, dogs must be on leash on beaches with breeding Hooded Plovers and this regulation must be operational in practice. If pairs are falling within off leash areas or unregulated areas, there needs to be consideration of changing/introducing the current zoning to be at least seasonal on leash access.
2) Determining the availability of off leash areas in the region of interest: are there adequate off leash areas available (across the shire)? Can an alternative off leash area be created if needed?
3) Identifying all the land managers and ensuring a consistent, integrated approach within a given region.
4) Investigating current levels of compliance with dog regulations where they exist: poor compliance will need to be addressed.
5) Seeking resources to carry out the below steps to improve compliance:
    a) Education campaign: in order to bring about change there needs to be motivation for this change. This can be achieved by using the Hooded Plover as a flagship species and educating dog walkers about the threats that off leash dogs pose to these birds. There are multiple ways to tackle education:
        - Brochures and website information
        - Local maps that clearly define the different zones of dog access and provide interpretation about threatened wildlife
        - Signage at beaches which provides information about the ways dogs impact the birds
        - Provision of dog leashes with conservation messaging (as an incentive to change)
        - Face to face education via ranger patrols (step one should not be to fine dog walkers, instead to explain why poor compliance is such an issue of concern), trained volunteers, and events such as Dogs Breakfasts (see page 137)
        - Newspaper articles to publicly debate and explain the issue

    b) Targeted enforcement: Without any perceived consequences, regulations can be viewed as unimportant and irrelevant to beach users, and thus ignored. Because it is thought that people are intrinsically egocentric, that is, they typically act in their own self interests (Hardin 1968), regulations that are enforced by a threat of penalty (e.g. fine) operate by making people behave in the public interest because it is in their own best interest to comply (Gardner and Stern 1996). Enforcement of regulations can have a flow-on effect, as other beach users may observe compliance with regulations and follow suit.
        - Regular patrol and enforcement of regulations where a log of hours expended patrolling, rates of compliance and identity of offenders is

maintained in order to implement a two-step approach to enforcement: step 1: education/warning, step 2: fine/penalty.

- If resources are limited, it can be beneficial to dedicate specific periods within the breeding season to intensive patrol. This can be timed around when pairs are actively nesting or have chicks.
- Patrols out of normal business hours as research into beach use has revealed a distinct dichotomy in beach use where locals tend to use the beach outside of work hours, either early morning or evening (Maguire *et al.* 2011a)
- Documenting and publicizing enforcement results will reinforce perceived consequences and assist with changing social norms.

6) If the above steps to improving compliance have not been effective over time (maximum 5 years), and the breeding success of the birds has not improved, then stricter restrictions to access need to be implemented, that is, either seasonal dog prohibition or year round dog prohibition.

Case Study: Dog access within the Mornington Peninsula National Park

Below are key excerpts from a discussion paper generated by Parks Victoria (2012) entitled: Dog walking activities in the Mornington Peninsula National Park.

National parks in Victoria are primarily managed for conservation purposes and are generally considered to be sanctuaries for native animals. Dog walking is usually not provided for in national parks and dogs are currently prohibited in the majority of Victoria's 46 national parks. Exceptions include the Mornington Peninsula, Great Otway[5], Greater Bendigo, Kinglake, Dandenong Ranges, Lake Eildon, Heathcote-Graytown and Lower Glenelg National Parks where dogs are permitted in specific restricted areas.

Where permitted in national parks in Victoria, dogs must be kept on leash at all times and can only be walked in areas set aside for dog walking under the National Parks (Park) Regulations 2004.

Dog walking had occurred along the Mornington Peninsula ocean beaches for many years including the period before much of the coastline was first declared in 1975 under the National Parks Act 1975 which was then known as Cape Schanck Coastal Park.

A Draft Management Plan for the Mornington Peninsula National Park prepared in 1996 recommended that dogs be prohibited from the park effective from March 1998. The ban

[5] Dog walking access and Hooded Plover habitat overlap in the area of Anglesea to Moggs Creek. Only since 2010 has this area become important habitat for the Hooded Plover after a ten year absence of the species. These beaches were in the species' historical range but due to population decline, local extinctions occurred at these sites and it was not until the Victorian population numbers began to recover due to considerable conservation effort that birds began to recolonise these beaches. This presents difficulties in managing threats of dogs at these beaches as few concessions for dog walking were made in Great Otway NP, however, these limited dog access areas now overlap with Hooded Plover breeding habitat.

was proposed to reduce conflicts with nature conservation objectives and other park users. At the time, many complaints and concerns were expressed about threatening dogs, dog attacks, annoying dog behaviour, interference with wildlife particularly the Hooded Plover and other shorebirds, and fouling of tracks and beaches. Due to the common practice of owners allowing dogs to run free many of these problems have been intensified.

In response to public submissions on the exhibited draft management plan, the final approved management plan (Parks Victoria 1998) introduced additional restrictions on when dogs could be walked rather than a blanket prohibition across the whole park. The approved management plan recommended a 12 month trial to monitor compliance with the new restrictions, and to consider further restrictions or a total prohibition if non-compliance with the regulations continued to be a major problem, and there were on-going impacts of dogs on park values and other visitors.

Further to this, Dowling and Weston (1999) published in a peer-reviewed journal an article which states "before 1998 there was an area designated for dog-walkers…However, compliance with laws was low; only 12% of dogs detected in the area, over the period 1991-1998, were controlled by leads (n=693 encounters). In September 1998 Parks Victoria introduced new regulations restricting dogs in the existing areas to the period from sunrise to 9:00. Compliance is still low, and unleashed dogs are still commonly seen in all parts of the study area at any time of day." The study looked at the success of breeding birds in zones of different management intensity: No dogs at any time, Plover Watch, Restricted access and Dogs at all times, and found that dog management significantly increased the proportion of clutches that hatched and that the proportion of chicks that fledged was significantly higher in the areas without dogs. "This suggests that chick mortality, the main causes of which are unknown, is related to the presence of dogs."

Following the 12 month trial and despite on-going impacts and poor levels of compliance with the regulations, no changes to the dog walking regulations were made until 2009 when a seasonal Shorebird Protection Zone was established in the Portsea Surf Beach area.

In October 2012, the public consultation process began for reviewing dog regulations within Mornington Peninsula National Park. This presented four options for consideration.
1. A seasonal ban for the whole park where dogs are currently permitted
2. Restricting dogs to designated visitor sites and adjacent beach areas
3. A seasonal ban in selected areas
4. A total ban for the whole park.

BirdLife Australia used the following criteria to reach the recommendation that a total ban for the whole park was warranted given:

1. The severity of the impacts posed by dogs in the park [consideration of intensity of access, evidence of nest failure and disturbance]: threat data from the MPNP revealed three times as many dogs off leash than on leash in the park (Table 14), bird monitors produced multiple photos of dogs chasing breeding birds and running through signed and fenced nesting areas.
2. The value of the area of concern to the species: The Mornington Peninsula National Park contains 11.95% of the Victorian population (Table 4).
3. Breeding success within the area of concern and how this compares to elsewhere across the State and in Australia: Table 10 reveals that the Mornington Peninsula has the lowest rates of breeding success reported across Victoria.
4. Compliance data within the area of concern [is there evidence of change over time, how well are park users complying with current regulations, does this vary across regulation zones (i.e. across no dog zones, seasonal restricted access zones, or year-round restricted access zones)]: compliance is incredibly low in dog permitted areas, where dogs off leash are three times greater in number than dogs on leash, and dogs are frequently in the park outside of permitted hours (after 9am). Compliance however, is much greater in dog prohibited areas, where dogs are rarely recorded (in less than 5% of observations).
4. Historical measures taken to tackle the issue [that is, have there been efforts to educate dog walkers and improve compliance, have there been enforcement patrols, how effective have these measures been relative to investment]: there has been significant investment into education and enforcement in the park for twenty years in an effort to conserve Hooded Plovers. This has not resulted in improved compliance rates, with the exception that dogs prohibited areas have remained dog free.
5. Provision of off leash areas elsewhere in the region: the Mornington Peninsula has an abundance of off leash areas provided by the shire.

The outcome of the public consultation process was announced in early June (2013). There were 683 submissions received and of these 52.1% sought greater restrictions or a total ban on dog access to the national park and 44.1% sought the status quo or fewer restrictions (Context Pty Ltd. 2013). The singular management option gaining the strongest support was a total ban - 44.5% of submissions. A majority of the public submissions (47.7%) expressed a desire for increased enforcement.

An additional 7 km of beach was designated for a year-round ban on dog access. This equates to greater protection for an additional five pairs of Hooded Plovers. Fifty percent of breeding sites however are still accessible to dogs and hence remain subject to impacts of off-leash dogs. In two years the decision will be reviewed. Thresholds for change have not been determined and will be critical to determining whether this decision has effectively improved the outlook for Hooded Plovers within the park. Given projected population declines within ten years, improvements in dog compliance are time critical if the species is to persist.

Event management

When an event brings thousands of participants and spectators to a beach for the day, there is great potential for nest failure or chick death to occur as threats will be highly concentrated in space and time. There are also risks associated with vehicles using the beach to transport equipment and infrastructure for the event (e.g. 4WDs or Gators).

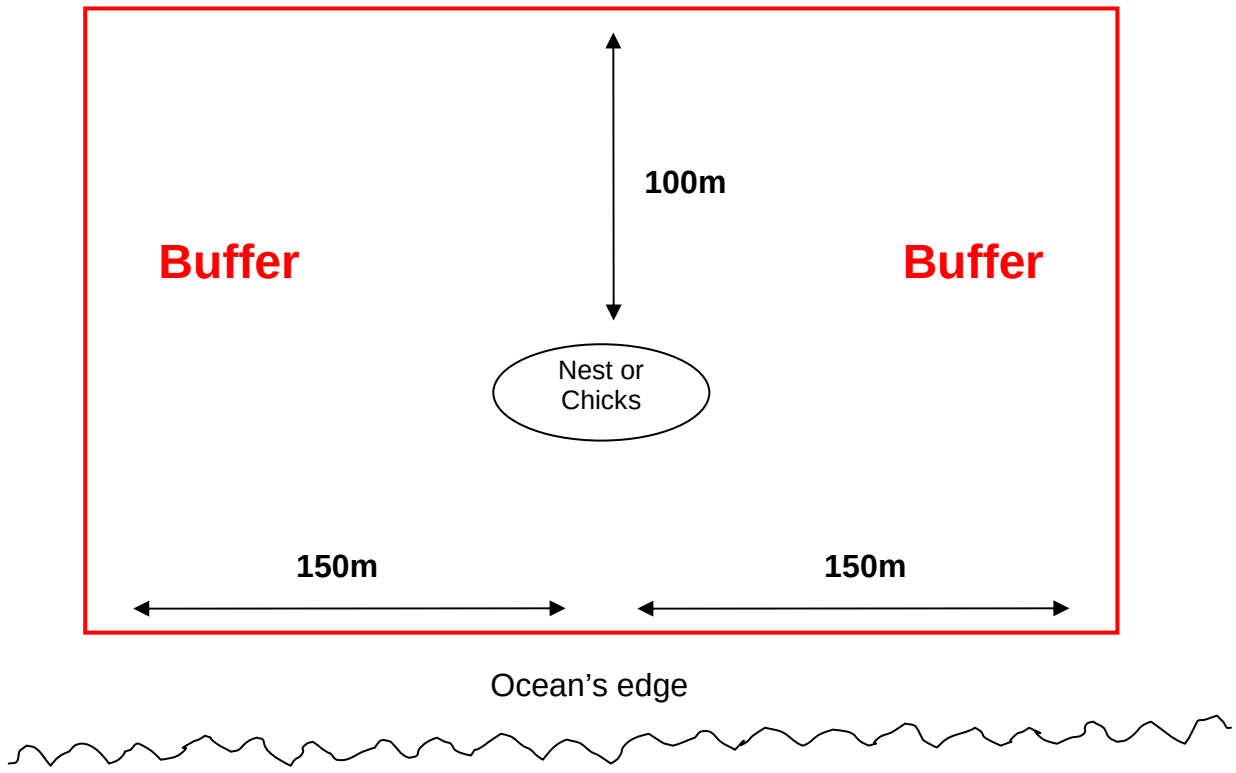
Below are the main considerations that need to be made. However, it must be noted that when Hooded Plovers are caring for chicks, they can roam up to several kilometres and this can occur within the space of a day. This makes it hard to predict ahead of the event where the birds will be on the day of the event, and thus it is essential that qualified persons (such as BirdLife Australia staff, trained volunteers, trained rangers) communicate with event organisers prior to set up on the morning of the event to convey the most up-to-date information. Volunteers will also need to adapt the breeding site protective set up on the morning of the event to account for birds being in a different area.

In the lead up to the event, the area must be regularly visited to determine the breeding status of pairs.

For nests with eggs, a buffer zone in Figure 24 below should be adhered to. A 'buffer' is defined as the required distance you need to be away from the active nest. This area can be passed by along the water's edge only but no activity can be carried out within the buffer zone. Typically, signage and rope fencing plus additional volunteer wardens to steer people away from the buffer zone are effective at protecting the birds during an event.

If the breeding pair has chicks, it becomes more difficult to protect them as they are mobile and may move about across a 1-2 km stretch of beach. This will mean that on the day of the event, pre-set-up, a qualified observer must do a check of the area prior to commencement of activity to identify the current location of the chicks. Upon locating the chicks, the buffer zone in Figure 24 below should be adhered to.

Figure 24. Diagram indicating the buffer zone (highlighted in red) around nests or chicks during an event.



Recommended event protocols

1. Event personnel setting up, packing up and present during the event

Staff walking on the beach can adversely affect the survival of nests and chicks of Hooded Plovers in direct ways (crushing) and indirect ways (disturbance). Furthermore, if the event personnel are too close to breeding sites, there are added risks of prolonged disturbance.

Any event staff using the beach must ensure that:

- They are made aware of the current nesting situation of Hooded Plovers on the beach so as to exercise extreme caution when traversing the area – this condition can be met by briefing all staff prior to the day about the location of birds and their breeding status (i.e. whether they have eggs or chicks) and again on the morning of the event.
- Access to the site is via designated tracks and pathways only.
- Ideally, the beach is not accessed in the period one hour either side of high tides, as when the tide is at its highest, the person has no choice but to walk above the HTM.

- They walk along the water's edge on the wet sand and they do not enter the upper beach or dune.
- They do not pause within the buffer zone/s around breeding birds but only pass by the area as is necessary.
- Event staff should act on the event day to ensure that the buffer zone is kept people-free and this may involve regularly conversing with event attendees to explain why.

2. Vehicles and SLSC quad bikes needing access to the beach

It is assumed that only event staff and surf life savers will require vehicle access to the beach. This protocol is designed for these staff using vehicles for setting up and packing up the event, as well as on the day of the event.

Event staff and SLSC vehicles accessing the beach must ensure that:

- They are made aware of the current nesting situation of Hooded Plovers so as to exercise extreme caution when traversing the area.
- Access to the site is via designated tracks and pathways only.
- The beach is not accessed in the period one hour either side of high tides, but only at times of low or medium tide level with enough room for the vehicle to be below the HTM. In the case of emergency vehicles needing access to the site, this would not apply, however, care should still be taken to avoid the nesting areas and drive as close to the water's edge where possible.
- All vehicles are driven along the water's edge to minimize the likelihood of crushing flightless chicks and disturbing nesting birds and chicks.
- All vehicles are driven at low speeds (~25 km/h) and in poor weather or low light conditions, speeds are further reduced.
- Drivers should remain vigilant for any movement of birds at the water's edge and slow down further if they spot birds or their chicks and wait for them to move out of the way.
- Vehicles and staff do not stop within 300m of the birds, in the event of chicks being present.

3. The event: crowds traversing the beach and attending the event

People attending the event can impact egg and chick survival when traversing the beach and surrounding area and when settling in an area to watch the event, especially if too close to active nests or chicks.

- An announcement at the beginning of the event should be broadcasted to inform the public of the location of breeding birds and the need to keep well away from the signed areas, for example, "Hooded Plovers are currently breeding on the Point Lonsdale back beach. Hooded Plovers are a threatened species and their eggs and chicks die when they are exposed to too much disturbance. Please obey all signage and keep well away from the fenced nest sites."

- Event marshals need to remind attendees as the event progresses of the presence of breeding birds and the need to keep out of the buffer zone, particularly if they see attendees breaching the buffer zone.
- Volunteer wardens must be present on the day of the event, specifically set up at the edges of the buffer zone/s to reinforce signage and keep attendees out of the area. Wardens are also there to raise awareness about the birds and answer questions by the public.
- Signage around the buffer zone indicates that attendees are to walk past the area along the water's edge and not to linger in the signed area. They are asked not to enter the upper beach or dune.
- Beach access is encouraged via designated pathways and these are clearly demarked for attendees.
- Fencing around the breeding site is as wide as allows attendees to pass by the water's edge and this can be widened and shortened as the day progresses and the tide height changes, by having additional lengths of rope and stakes to bring the two sides out to the water's edge (see photos from Portsea Ironman event in the Mornington Peninsula National Park).
- If there are chicks, shelters need to be placed within the buffer zone and these should be placed on the upper beach (safe from a rising tide but as low as is manageable) so the chicks have cover close to their feeding area.

View from access point where nesting zone is to the left of the access stairs and signage along fence line is visible plus wardens situated in front of this area. The event was to the right of the access stairs.

View from inside buffer zone of fence line, signage, wardens sitting nearby and crowd further behind this area.

View from inside buffer zone of birds at high-tide mark (HTM), shelter situated about 7 metres above the HTM with entrance facing the water and adjustable fence line, banner and wardens in background.

Surf life savers set up on edge of fence line.

Education

Coastal flagship

Flagship species are used in education and conservation campaigns to raise the profile of the particular species and at the same time, to successfully leverage more support for biodiversity conservation at large in a particular context.

The key features a 'flagship' species should possess are distinctiveness, vulnerability, accessibility and charisma. Hooded Plovers meet these criteria. They are highly accessible to the average beach-visiting person (not just bird watchers). BirdLife Australia's Beach-nesting Birds program is unique in comparison to many other bird (and wildlife) conservation programs in that it has attracted predominantly coastal residents and recreationists, relative to other programs which have higher participation from birdwatchers and people already belonging to environmental groups such as Landcare, etc (G. Ehmke unpublished data). Because beaches are one of the most highly valued natural areas for human visitation (Maguire *et al.* 2011a), Hooded Plover conservation programs present a successful platform for education about human threats to coasts.

Coastal environments are under considerable threat from erosion from human access and use of dunes; coastal development (particularly in the primary dune leaving no room for coastal retreat), and; threatening processes related to recreational use. Direct links can be made between the persistence and breeding success of this species and coastal management issues that concern park managers such as coastal weeds, unbalanced recreation, poor compliance with regulations, and introduced predators. This makes the species a perfect 'flagship' candidate for highlighting to park users the problems facing coastal environments.

The breeding success experienced by Hooded Plovers is followed closely by coastal residents via local media and nest update signage at beach access points, so that residents can broadly relate their behaviour, or behaviour change, to the success experienced by the birds. This not only acts as an educational tool but also a motivator for social change, e.g. a reason for people to abide by dog leashing regulations where they can see a direct benefit of their actions.

BirdLife Australia's Beach-nesting Birds Education Program

The BNB project developed a wide range of activities and resources via its education program that assist teachers, environmental educators and interpretive programs in relaying consistent messages using trialled and proven methods.

Education Kit

This kit allows educators to have a range of lessons at their finger tips. It is available in electronic or hard copy, and outlines in detail seven activities suitable for primary school and early secondary school students. These include classroom activities and presentations, conservation actions such as building chick shelters and tips for how to run a beach visit. All presentations and printable materials are available on the provided disk.

The Wing Thing

This is an informative activity booklet complete with comics, crosswords and games. It works as a stand-alone awareness raising tool which can be distributed to local coastal communities (for example, to libraries, information centres, schools, etc), or can be used in conjunction with the on-line resources. On the Culture Victoria website there are images, videos and an interactive on-line animation where kids can learn about the threats to hoodies and their life on the beach. In addition, teachers can download the Hooded Plover curriculum resource for Years 3 – 5, developed by BirdLife Australia in conjunction with the Gould League. This is a unique resource which strongly links art, social science and coastal conservation.

A Dogs Breakfast

This event, which specifically targets the education of dog owners, provides a positive environment to raise awareness of the impact dogs can have on the breeding success of beach-nesting birds. A free BBQ is provided to dog owners (plus a dog treat for their pets), with information and give-aways ('birds and beaches, dogs and leashes' brochure, dog leads with a printed conservation message). The BNB project provides a detailed description on how to organize and run this event available on request.

Conservation Craft Activities

Craft activities include colouring sheets, an informative 'flick-flack', healthy hoodie habitat sheet, badge making and/or painting calico bags. The BNB project provides a detailed description on how to undertake bag painting in a session or stall setting.

Additional awareness raising materials are also available and include stickers, swap cards, plus a range of brochures targeting different audiences (surfers, horse riders, dog walkers, cat owners, visitors staying at accommodation near Hooded Plover beaches, etc).

Parks Victoria and BirdLife Australia education activities to date

To date BirdLife Australia has worked with Parks Victoria in a range of education and awareness raising avenues include school presentations, summer activities and market stalls.

Apollo Bay Saturday Markets

Parks Victoria, Otway Coast Committee, Southern Otway Landcare Network and BirdLife Australia joined together to host an information and conservation craft stall at the five busiest Apollo Bay Saturday Markets during the 2011/12 Hooded Plover Breeding Season. This market is held on the foreshore area of Main Street in Apollo Bay and has significant numbers of visitors and locals passing through. The four groups worked together to man the stall and interacted with more than 200 people on each of these mornings, thus targeting over 1000 people during the summer peak of the breeding season. This was an amazing outcome and working together meant it was achieved with minimal effort.

Junior Ranger Summer Program Mornington Peninsula National Park

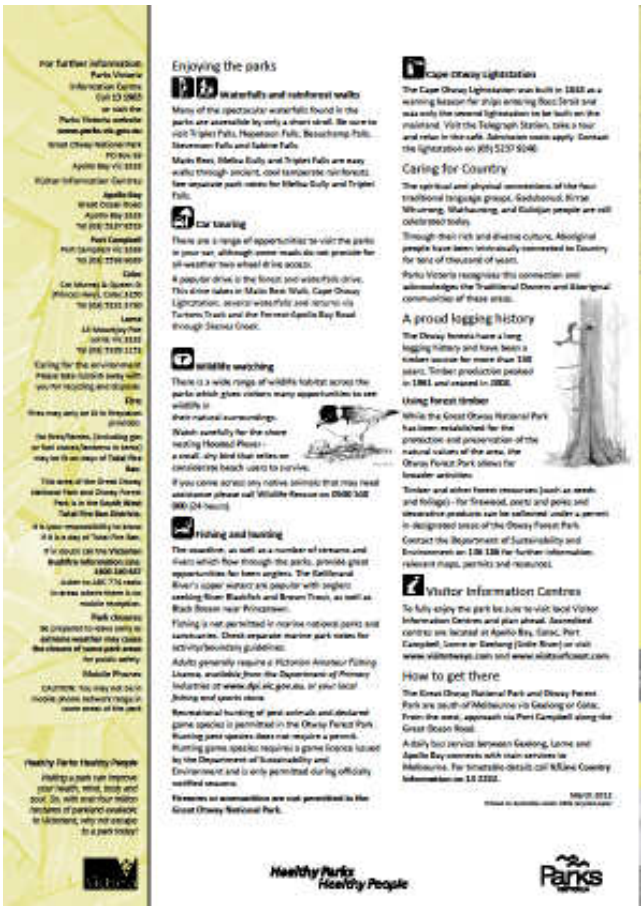
Kim Cott, Parks Victoria Ranger from the Mornington Peninsula National Park, incorporated Hooded Plover activities into her Summer Junior Ranger program in 2012. She worked with BirdLife Australia's Beach-nesting Birds Project and the local Friends of the Hooded Plover group to run Conservation Craft events. The incorporation of such events into the Program has been extremely successful. The Portsea back beach event reached 39 individuals, but information about threats to the Hooded Plover now reach most of the 500 kids involved in the Junior Rangers program on the Mornington Peninsula each year.

Wilsons Promontory National Park

BirdLife Australia has worked with Parks Victoria staff at Wilsons Promontory National Park to undertake a range of holiday programs during 2011 and 2012. These included kid's education sessions (conservation craft and shorebird stories), evening presentations to rangers and campers, beach walks and training sessions for Hooded Plover monitoring. These events targeted a range of Parks Victoria staff, locals (Friends of the Prom) and campers/visitors to the park, reaching approximately 150 individuals that use and/or manager Hooded Plover habitat.

Park Notes

Of the 28 parks with Hooded Plovers across Victoria, 18 of these have Park Notes publications. Only 56% (10) specifically mention Hooded Plovers. It is recommended that parks with key importance to Hooded Plovers such as Wilsons Promontory, Croajingalong National Park and Cape Liptrap Coastal Park add mention of this species to their Park Notes. To the right is an example of the Great Otway National Park – Park Notes for the West Otways.



Enjoying the parks

Waterfalls and rainforest walks

Car touring

Wildlife watching

Fishing and hunting

Cape Otway Lightstation

Caring for Country

A proud logging history

Visitor Information Centres

How to get there

Healthy Parks Healthy People

Parks

Interpretive or permanent access point signage

There are several parks which have sought to install Hooded Plover signage at beach access points to highlight to visitors before they reach the beach the importance of the location and to forewarn them of managements they may see in place on the beach, such as temporary fencing or signage.

Breeding site specific management options

Protection of the breeding site (formerly referred to as Temporary Beach Closures, TBC) is the most effective means of improving breeding success that we currently are aware of (see Box 1).

Below are the basic steps for installing signage and fencing around the breeding site, treating sites with eggs and chicks differently.

Protection of the breeding site during the egg phase

Materials needed

- 8-10 star pickets (plastic caps needed if using metal pickets)
- 40-50 metres of colourful nylon rope (4-6mm diameter)
- mallet or flat rock for hammering stakes in
- 2-4 signs affixed on poles with plyboard backing (2 either end and option of 2 facing water along front of area) [make these up in the carpark prior to reaching site; need tacks or staple gun, plus wood glue to affix sign to board; nails to affix board to stake]
- permanent marker to write a date range on signs (+28 days for eggs, +35 days for chicks)
- tape or cable ties to fasten rope to stakes and to strengthen at ends
- knife to cut rope
- binoculars

Instructions for installation

- The fence has to be big enough to keep the nest's location secret - leave at least 10-15 metres either side of nest. If you have more room to move on the beach and the space can be afforded, bigger is better!
- Signs need to be at least 10 metres out from edge of fences (people approach to read so we don't want an approach to the edge of the fence itself). Try to have signs as low on beach as the high tide allows.
- Avoid extreme weather (heat, cold, rain, strong wind) – unless nest has been found in heat and needs to urgently go up – then you will have to potentially work very quickly or put it up in sections allowing for time in between for the bird to incubate.
- Do not spend more than 35-40 minutes putting it up - and this is in good, mild conditions.
- The trick to fencing quickly is to lay your stakes out first – spacing them out and making sure you have enough to cover area. Then hammer them in solidly, they should roughly be 1.4m high. Then start from one end and unravel and tie/fix rope to each pole as you go (make sure your rope is not in a knot prior to getting to site, have it on a reel for ease of unravelling).

- If very hot (between 27 to 32°C) but fence must go up because at immediate risk, then spend 10 minutes maximum. Hotter than 32°C put up multiple signs quickly and come back in better conditions for fence. If very windy, assess how quickly eggs are getting buried. Abandon fencing if this is beginning to happen and just put signs up. Come back in better conditions.
- Look around for predators before putting up fence, if ravens or gulls close by, wait til they go or scare them out of area first and make sure they are gone before you approach nesting spot. Make sure there are no off leash dogs approaching area.
- Make sure you never lose sight of eggs as you go about putting fence up.
- Once fence is complete, walk away along water's edge so birds see you leaving. Once about 60-80 metres away, see if birds are going back on nest. If they still are reluctant to return, place yourself at about 100m and bob down and watch through binoculars. Make sure they come back to nest! If not, you might have to walk well away (1km), wait for 30 minutes, walk back and if still not back on, fence needs to come down and just leave signs up. [This shouldn't happen if you've used the right materials and the fence is big enough!]

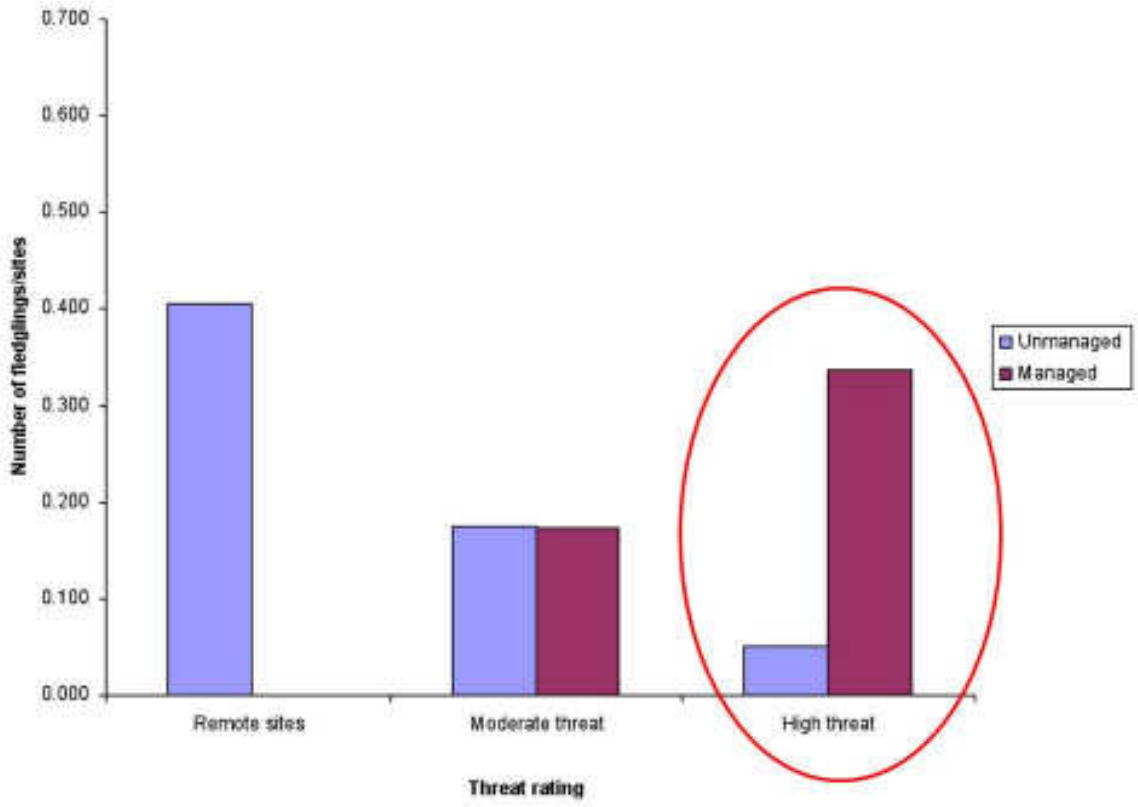
Protection of the breeding site during the chick phase

After hatching, the birds can benefit greatly from altering the configuration of signage and fencing to better reflect the area the chicks are using, and so that beach users do not presume the chicks stay in the nest.

- Locate family of birds first – make sure you know which area they are using.
- Before moving signs/fences or placing shelters, you must know where the chicks have hidden and be very careful not to walk into this area – you need to keep an eye on them the whole time you are there in case they move.
- You may need to move signs to encompass new foraging area – if this is a large area, you will need extra signs to make it clear to public how big the area is (2 signs aren't enough if you can't see the furthermost sign from the first sign). It may be worthwhile to have 2 signs either end facing east/west, and multiple signs along the beach facing north/south; delineating an area of upper beach/dune.
- Switch from a standard nesting sign to a 'chicks on the beach' sign.
- If the birds are using a small area, you can consider fencing this off – as fences can be a great refuge for chicks to run within.
- If the chicks are using a bigger area of beach (i.e. greater than 100-150m), then the fence might not be feasible. Consider fencing two ends of the area.

Box 1. For heavily threatened sites (human pressures), management investment at the nest site can increase breeding productivity tenfold, and can give pairs on these heavily impacted sites an equivalent chance of producing young to remote breeding sites (with no to very little human access) (see Figure 25). There appears to be less benefit from managing nesting sites at moderately threatened sites, and preliminary analysis reveals that at these sites a combination of 1) predators and 2) low compliance with nest protection signage/fencing, are driving this difference. In other words, at heavily threatened sites, once human recreational threats are managed, the birds are quite successful, however, at sites still receiving regular visitation but at lower frequencies/intensity, breeding failures are often related to additional sources such as predators.

Figure 25. The number of fledglings/pair produced according to level of threats experienced at breeding sites (rated as remote, moderate and high threat) and according to whether the nest site was managed (e.g. fenced or signed). This figure is based on data from three consecutive breeding seasons (2006/07 to 2008/09).



- If the site is visited regularly, or if a volunteer lives adjacent to the site, it can be possible to improve the fencing on a daily basis by extending the leading edge down closer to the water mark at times of low tide and then towards high tide, reducing the fencing (have longer ends of rope that can be extended). When this is done, the signage can also be moved closer to the water's edge. This is only an advantage when the beach is wide and in areas that receive lots of people/dogs etc. We have done this on long weekends, public holidays or very hot days that attract lots of visitors, as well as during events, to keep public as close to water's edge as possible and to ensure there are no sunbakers that sit in front of the fenced area.
- A large canvas banner 'chicks on the beach, look out' is very useful for wide beaches or sites with lots of visitors, as this can be seen from a great distance and is a great warning for beach users about to enter/pass by the fenced/signed area.
- Place 3-4 A-frame shelters along length of beach the birds are using; these need to be dug in 10-15cms deep, sand evened out so there are no big crevices inside, and camouflaged on outside with sand (not seaweed – this could attract predators).
- When placing each shelter, do not travel along upper beach, move down to water's edge each time.
- Shelters need to face water and are best on the upper beach, halfway between dune base and high-tide mark.
- Useful if a chick update sign can be used at the access points –needs a volunteer to update it with a permanent marker.
- Useful to put a story in local newspaper to alert public to chicks.

Temporary rope ends demarking the area the chicks use with chick shelter placed within and signs at either end of the fence.

Temporary rope ends demarking the area the chicks use on a busy beach (Portsea) with chick shelters placed within and signs at either end of the fenced area.

Signs and fencing can be ineffective without community awareness. In this scene, beach users sit directly in front of the fenced area – so that the birds are too disturbed to incubate. Beach users have thought by staying out of the fenced area they are not doing any harm…

Every site is unique so you may need to tailor your signage to suit your needs.

The same beach after the additional signage was put in place.

Temporary rope ends demarking the area the chicks use with chick shelters placed within and signs at either end of the fenced area. The fence has been extended during low tide.

More examples of temporary and permanent fencing and signage.

The links https://vimeo.com/42055832 and http://vimeo.com/20005173 provide video footage of the effectiveness of temporary fencing.

Park by Park Recommendations

Table 19 provides an overview of the key user groups within each park (as in Chapter 3, Table 15) with recommended avenues for conveying information to these specific user groups.

Below management recommendations are made for each park related to the current, dominant threats present. Parks do not appear in order of priority. An asterisk indicates that the specific management has previously been carried out and may be unlikely to need further action (e.g. permanent signage – may need future maintenance but is not an ongoing action).

Discovery Bay Coastal Park

Priority High

- Incorporate educational messaging into Great South West Walk brochures, park notes and website information
- Permanent signage at access points to warn beach users of presence of beach-nesting birds*
- Liaise with and educate dune buggy clubs and other permitted vehicle users to ensure responsible vehicle access and broader understanding of impacts of vehicles on the coast
- Investigate locations where vehicles are illegally accessing the beach and implement illegal vehicle management strategy
- Participation in biennial count*
- Seek to engage Friends of the Great South West Walk; a first step could be for the group to take on a section of the biennial count to be carried out on foot
- Yearly monitoring if resources permit, particularly to better identify locations of breeding sites and to estimate fledging success within the park
- Explore feasibility of extending Glenelg Ark fox control to the foreshore. If this is a large investment, it may not be tenable because it is currently unclear as to the degree of impact foxes have on nesting success in this region
- Consider using remote cameras on nests to explore nest fates in this park – as regular nest monitoring may not be logistically possible due to difficult access

Narrawong Coastal Reserve

Priority High

- Permanent signage at access points to warn beach users of presence of beach-nesting birds*
- Protect nest sites near the mouth of the Surry River (high use areas)

- Liaise with Mouth 2 Mouth fun run to ensure risks to birds are adequately managed during and in preparation for the event (e.g. including location of drink stations being distanced from active breeding sites)
- Investigate locations where vehicles are illegally accessing the beach and implement illegal vehicle management strategy
- Investigate the feasibility of a higher land reservation status or a means of introducing a regulatory framework for recreational access to the reserve
- If horse use increases within this reserve or is revealed to be negatively impacting breeding success, implement horse access management strategy
- Establish appropriate dog access regulations and breeding season enforcement (first offence: warning with education, second offence: fine)
- Ensure all vehicle users legally accessing the park (including Surf Life Saving Club) are aware of threats to birds and follow vehicle access protocols
- Participation in biennial count*
- Meet with Friends of the Surry and Portland Field Naturalists on an biannual basis to informally review management issues in the reserve and adjust where necessary strategies for improvement

Eumeralla (Yambuk) Coastal Reserve

Priority High

- Permanent signage at access points to warn beach users of presence of beach-nesting birds*
- Protect nest sites near the river mouth (high use area) and within 100m of access points
- Investigate the feasibility of a higher land reservation status or a means of introducing a regulatory framework for recreational access to the reserve
- Establish appropriate dog access regulations and breeding season enforcement (first offence: warning with education, second offence: fine)
- Participation in biennial count*
- Encourage caravan park hosts to provide information to visitors about the presence of beach-nesting birds

Yambuk Flora and Fauna Reserve

Priority Mid

- Permanent signage at access points to warn beach users of presence of beach-nesting birds*
- Protect nest sites nearest access point (high use area)
- Implement horse access management strategy
- Participation in biennial count*

Belfast Coastal Reserve

Priority High

- This coastal reserve requires a management review and strategic planning to mitigate current threat levels which are some of the highest experienced by Hooded Plovers across the Victorian coast
- Investigate the feasibility of a higher land reservation status or a means of introducing a regulatory framework for recreational access to the reserve
- Permanent signage at access points to warn beach users of presence of beach-nesting birds*
- Protect nest sites at the majority of sites*[6]
- Implement illegal vehicle management strategy, targeting area between The Basin and Rutledges Cutting
- Implement horse access management strategy
- Establish appropriate dog access regulations and breeding season enforcement (first offence: warning with education, second offence: fine)
- A summer ranger would be recommended for at least two seasons to liaise with locals and visitors and provide education and a regular presence in the reserve.
- Targeted Marram Grass and Sea Spurge removal – investigate restoring habitat
- Investigate ways of improving resilience of pairs to rising sea levels (e.g. raising seaward side nest sites on rocky berms with artificial platforms of tractor tyres and sandbags)
- Targeted fox den fumigation
- Targeted lethal fox control if multiple nests are taken by a fox in a given location
- Participation in biennial count*
- Meet with Friends of the Hooded Plover Far West on at least a biannual basis to informally review management issues in the reserve and adjust where necessary strategies for improvement

Bay of Islands Coastal Park

Priority Low

- Permanent signage at access points to warn beach users of presence of beach-nesting birds
- Nest site protection at Crofts Bay
- Targeted fox control at the time of active nesting
- Incorporation of educational messaging about Hooded Plovers into summer ranger program
- Participation in biennial count*

[6] High horse, vehicle and dog impacts are currently unregulated in the reserve and so there is a current need to protect individual nests. The need for site specific investment would be reduced if high impact threats were managed more effectively at the landscape scale.

Port Campbell National Park

Priority Low

- Permanent signage at access points to warn beach users of presence of beach-nesting birds
- Incorporation of educational messaging about Hooded Plovers into summer ranger program
- Targeted lethal fox control if multiple nests are taken by a fox in a given location
- Participation in biennial count*

Great Otway National Park

Priority Mid

- Nest site protection for nests nearest access points and by estuaries – due to more difficult beach access, consider fencing an area of the estuary in November and leaving up until to February (sanctuary zone) or at the very least, placing signage on the beach that provides a warning to beach users of the potential for nests/chicks in the area
- Ensure information given to tour companies as part of their commercial license
- Incorporate educational messaging into Great Ocean Walk brochures, park notes and website information
- Investigate the potential impact of dogs permitted at the Johanna beach campground has on dog use (and compliance) at Johanna beach
- Make information available to adjacent accommodation providers such as Bimbi Park, which is the main access to Station beach
- Ensure horse riders have adequate information regarding risks to beach-nesting birds
- Targeted patrol at Anglesea beaches to enforce dog regulations at peak nesting times (first offence: warning with education, second offence: fine)
- Targeted lethal fox control if multiple nests are taken by a fox in a given location
- Participation in biennial count*
- Meet with Friends of the Hooded Plover Otway and Surf Coasts on an annual basis to informally review management issues in the reserve and adjust where necessary strategies for improvement

Eagle Rock Marine Sanctuary (Aireys Inlet)

Priority Low

- Potential to exclude access from rocky point with one sign and rope barrier when birds actively nesting; beach users have a very large alternative use area
- Targeted lethal fox control if multiple nests are taken by a fox in a given location

- Patrol close to hatching if possible to ensure dog regulations being abided by
- Liaise on an annual basis with other land managers on the Bellarine and Surf Coast to ensure a consistent approach to Hooded Plover conservation
- Participation in biennial count*

Point Addis

Priority Low

- Requires minimal signage around nesting site plus rope sides
- Targeted lethal fox control if multiple nests are taken by a fox in a given location
- Participation in biennial count*

Lonsdale Lakes Wetland Reserve

Priority Mid

- Ensure Hooded Plovers are considered in any review of management or plans for development on the boundaries of the reserve
- At least one winter survey per year
- Participation in biennial count*

Port Phillip Heads Marine National Park

Priority Low

- Nest site protection for nests nearest access point (2W and 3W)
- Liaise on an annual basis with other land managers on the Bellarine and Surf Coast to ensure a consistent approach to Hooded Plover conservation and maintaining and improving compliance with dog regulations.
- Participation in biennial count*

Mornington Peninsula National Park

Priority High

Below are the priority managements within the park. This is a subset of those listed as high to critical priority as part of a stakeholder review of the Management Plan for the Hooded Plover within the National Park (in prep):

- Nest site protection (temporary rope fencing and temporary nest signage) for the majority of sites, with the exception of sites 200m SE of Gunnamatta to Fingal, and sites west of Gunida Ave to Alison Ave Rye
- Maintain nest update signage at high use beach access points
- Adapt fencing and signage post hatching, including installing chick shelters
- Provide targeted ranger presence at sites with chicks aged between 1-15 days after hatching[7]
- Incorporation of educational messaging about Hooded Plovers into ranger patrols and summer ranger program
- Invest in patrols and enforcing current dog walking regulations giving emphasis to breeding season, breeding sites and identified periods of non-compliance (e.g. morning and evening)
- Review Hooded Plover breeding success and compliance with dog leashing in May 2014 and May 2015 in relation to the effectiveness of the dog access changes effective September 2013
- Maintain records of threats, management presence/activity and compliance of park visitors
- Continue to provide a permanent ranger as a program coordinator and seasonal support for carrying out nest and chick site protection, public education and liaison with volunteers
- Establish and maintain an effective and fast nest/chick reporting system to ensure rangers receive notification of nests at risk as they arise and to facilitate prompt responses for nest protection as required
- Ensure permits for horse riding tour operators address Hooded Plover protection needs and monitor and respond to compliance with permit conditions
- Install and maintain interpretive and regulatory signage addressing horse riders*
- Undertake site induction for all contractors using vehicles on beaches
- Engage with surf lifesaving clubs to ensure Hooded Plovers are considered during SLSC events and operations, particularly vehicle use on beaches
- Targeted lethal fox control if multiple nests are taken by a fox in a given location
- Close informal tracks. Routinely monitor for any new tracks and close as required (see case study on page 162)
- Participation in biennial count*

Point Nepean National Park

Priority Mid

- Nest site protection for nests along bay side of peninsula
- Permanent signage at beach access points
- Ensure Hooded Plovers are considered in any review of management or plans for development of the park

[7] This is listed as a priority action within the Mornington Peninsula National Park largely because of the standout low chick survival of this region comparative to other parts of Victoria.

- Work closely with Mornington Peninsula National Park to ensure a consistent approach to Hooded Plover conservation
- Seek to maintain current levels of park use
- Provide educational messaging in brochures and materials available at Visitor Information Centre
- Incorporation of educational messaging about Hooded Plovers into summer ranger program
- Targeted lethal fox control if multiple nests are taken by a fox in a given location
- Participation in biennial count*

Punchbowl Coastal Reserve

Priority Low

- Permanent signage at beach access points
- Inclusion of information about the Hooded Plover in park notes for the George Bass Coastal Walk
- Participation in biennial count*

Kilcunda – Harmers Haven Coastal Reserve

Priority High

- Permanent signage at beach access points*
- Protection of nest sites in high use areas
- Consider signage for dune located nests given regular static recreational use (e.g. fishing)
- Investigate the feasibility of a higher land reservation status or a means of introducing a regulatory framework for recreational access to the reserve
- Continue to implement current horse access permit system and induction (plus quiz) for horse riders
- Establish appropriate dog access regulations and targeted enforcement at peak nesting times (first offence: warning with education, second offence: fine)
- Ensure all vehicle users legally accessing the park (including fox contractors) are aware of threats to birds and follow vehicle access protocols
- Targeted lethal fox control if multiple nests are taken by a fox in a given location
- Participation in biennial count*
- Meet with Friends of the Hooded Plover Bass Coast on a biannual basis to informally review management issues in the reserve and adjust where necessary strategies for improvement

Bunurong Coastal Reserve

Priority Low

- Permanent signage at beach access points*
- Protection of nest sites due to morphology of beaches (small bays)
- Investigate the feasibility of a higher land reservation status or a means of introducing a regulatory framework for recreational access to the reserve
- Establish appropriate dog access regulations and enforcement at peak nesting times (first offence: warning with education, second offence: fine)
- Targeted education of anglers to reduce litter, in particular fishing line and bait bags
- Targeted lethal fox control if multiple nests are taken by a fox in a given location
- Participation in biennial count*
- Meet with Friends of the Hooded Plover Bass Coast on a biannual basis to informally review management issues in the reserve and adjust where necessary strategies for improvement

Cape Liptrap Coastal Park

Priority High

- Permanent signage at beach access points*
- Protection of nest sites nearest access points, namely South 1, Between beach 3 and 4, North of 5
- Targeted campaign for educating and mitigating threats imposed by pipi collectors
- Targeted patrol to enforce dog regulations at peak nesting times (first offence: warning with education, second offence: fine)
- Ensure all vehicle users legally accessing the park (including Surf Life Saving Club) are aware of threats to birds and follow vehicle access protocols
- Targeted lethal fox control if multiple nests are taken by a fox in a given location
- Incorporation of educational messaging about Hooded Plovers into summer ranger program
- Participation in biennial count*
- At least 5 visits per breeding season in a vehicle along the entire park to survey Hooded Plover breeding
- At least one winter survey per year
- Meet with Friends of Venus Bay Peninsula and Friends of the Hooded Plover South Gippsland on a biannual basis to informally review management issues in the reserve and adjust where necessary strategies for improvement

Wilsons Promontory National Park

Priority High

- Protection of nest sites at Squeaky beach, Picnic beach and Derby beach that are subject to high visitor pressure from November to February, this includes dune nests as the area is subject to frequent static beach users
- Permanent interpretive signage at Squeaky beach, Picnic beach and Derby beach to warn beach users of the presence of nesting birds and the potential threat they pose
- Incorporation of educational messaging about Hooded Plovers into summer ranger program
- Ensure all vehicle users legally accessing the park (including fox contractors) are aware of threats to birds and follow vehicle access protocols
- Targeted Sea Spurge removal to ensure key nesting sites at Squeaky beach, Picnic beach and Derby beach are not lost over time
- Targeted cat control at Squeaky beach
- Targeted lethal fox control if multiple nests are taken by a fox in a given location
- Participation in biennial count*
- Seek to engage Friends of the Prom; a first step could be participation in sections of the biennial count and a commitment by the group to take this on into the future
- Yearly monitoring if resources permit, especially at Cotters beach, particularly to better identify locations of breeding sites and to estimate fledging success within the park

Shallow Inlet Marine and Coastal Park

Priority Mid

- Ensure all vehicle users legally accessing the park (including Surf Life Saving Club) are aware of threats to birds and follow vehicle access protocols
- Participation in biennial count*

Nooramunga Marine and Coastal Park

Priority Mid

- Aim for fox free islands, particularly continuing fox control on Snake and Dream islands.
- Participation in biennial count*

McLoughlins Beach – Seaspray Coastal Reserve

Priority Low

- Assess habitat condition to determine potential suitability for Hooded Plovers, particularly if research regarding dispersal reveals barriers around this part of the coast.
- Participation in biennial count*

Gippsland Lakes Coastal Park

Priority Low

- Educational messaging at boat launching areas
- Participation in biennial count*

Lakes Entrance – Lake Tyers Coastal Reserve

Priority Low

- Protection of nest sites nearest access point
- Investigate the feasibility of a higher land reservation status or a means of introducing a regulatory framework for recreational access to the reserve
- Establish appropriate dog access regulations and enforcement at peak nesting times (first offence: warning with education, second offence: fine)
- Ensure all vehicle users legally accessing the park (including fox contractors) are aware of threats to birds and follow vehicle access protocols
- Participation in biennial count*

Ewing Morass Wetland Reserve

Priority Low

- Participation in biennial count*

Marlo Coastal Reserve

Priority Mid

- Nest sites at the mouth of the Snowy river often benefit from Little Tern protective fencing

- Permanent signage at access points or camp sites to warn beach users of presence of beach-nesting birds
- Investigate the feasibility of a higher land reservation status or a means of introducing a regulatory framework for recreational access to the reserve
- If horse use increases within this reserve or is revealed to be negatively impacting breeding success, implement horse access management strategy[8]
- Targeted lethal fox control if multiple nests are taken by a fox in a given location
- Participation in biennial count*

Cape Conran Coastal Park

Priority Mid

- Permanent signage at key access points to high use beaches or camp sites to warn beach users of presence of beach-nesting birds
- Liase with the Southern Ark fox control program to include key foreshore habitat
- Participation in biennial count*

Croajingalong National Park

Priority High

- Incorporate educational messaging into hiking brochures, park notes and website information
- Permanent signage at key access points to high use beaches or camp sites to warn beach users of presence of beach-nesting birds*
- Liase with the Southern Ark fox control program to include key foreshore habitat
- Participation in biennial count*
- During biennial count, pay particular attention to whether birds are identifiable (e.g. banded or flagged). Detection of birds from NSW is of particular interest.
- Consider using remote cameras on nests to explore nest fates in this park – as regular nest monitoring may not be logistically possible due to difficult access

[8] Horses were not detected in threat assessments, however data was more limited for East Gippsland sites. Horses are permitted in Marlo Coastal Reserve.

Table 19. The target user groups for each park, whether they are predominantly static or mobile recreationists, whether the approach to education needs to be general or specialist, whether the users are mostly local or tourists, the nearest townships to the parks and recommended avenues for conveying information to user groups.

PARK NAME	TARGET USER GROUP 1	TARGET USER GROUP 2	STATIC OR MOBILE	GENERAL MGMT OR SPECIALIST	LOCAL OR TOURIST	NEAREST TOWNSHIP/S	AVENUES OF CONVEYING INFO TO USER GROUPS
Discovery Bay Coastal Park	hikers		mobile	specialist	tourist	Portland, Nelson	Camp sites, Tourist info centres, Hike notes
Narrawong Coastal Reserve	walkers	surfers, swimmers	mobile, static	general	local	Narrawong	Caravan park, Pontoon/track notices
Eumeralla (Yambuk) Coastal Reserve	dog walkers	walkers	mobile	general	local	Yambuk	Caravan park
Yambuk F.F.R.	walkers	horses	mobile	specialist	local	Yambuk	Carpark notices, caravan park
Belfast Coastal Reserve Coastal Reserve	dog walkers	horses	mobile	specialist	local	Warrnambool, Port Fairy	Local vet clinics, Horse trainers, Horse feed stores, Horse Permit system
Bay Of Islands Coastal Park	fishing	sitting	static	general	tourist	Peterborough	Tourist info centres, carpark notices
Port Campbell National Park	fishing	walkers	static, mobile	general	tourist	Port Campbell	Tourist info centres, carpark notices
Great Otway National Park	hikers	dog walkers		specialist	tourist	Lorne, Apollo Bay	Tour companies, Hike notes, Tourist info centres, track notices
Eagle Rock Marine Sanctuary	walkers	sitting	mobile, static	general	local, tourist	Aireys Inlet	Tourist info centres, on beach notices, GORCC newsletter
Elliot River - Addis Bay Coastal Reserve	surfers	walkers	mobile, static	general	local, tourist	Anglesea	Tourist info centres, carpark notices, GORCC newsletter
Lonsdale Lakes W.R	walkers	dog walkers	mobile	general	local	Point Lonsdale	Track notices, Rip rumour news
Port Phillip Heads Marine National Park	sitting	swimmers, surfers	static	general	local, tourist	Point Lonsdale	Rip rumour news, access track notices

PARK NAME	TARGET USER GROUP 1	TARGET USER GROUP 2	STATIC OR MOBILE	GENERAL MGMT OR SPECIALIST	LOCAL OR TOURIST	NEAREST TOWNSHIP/S	AVENUES OF CONVEYING INFO TO USER GROUPS
Point Nepean National Park	swimmers, surfers	jetski, windsurf	mobile (water)	specialist	tourist	Portsea	Visitor centre, carpark notices, boat launching locations
Mornington Peninsula National Park	walkers	surfers, swimmers	mobile, static	general	local, tourist	Rye, St Andrews, Sorrento, Portsea	Tourist info centres, Track notices, On beach notices
Punchbowl Coastal Reserve	walkers		mobile	general	local	San Remo	Carpark notices
Kilcunda - Harmers Haven Coastal Reserve	walkers	dog walkers	mobile	general	local	Wonthaggi	Track notices, Horse permit system
Bunurong Coastal Reserve	sitting	swimming	static	general	tourist, local	Wonthaggi, Inveroch	South Gippsland Enviro centre (Inverloch), Cape Paterson Eco Village hub, access track notices
Cape Liptrap Coastal Park	pipi	walkers	static , mobile	specialist	tourist, local	Venus Bay	Fisheries information, carpark notices, local general store
Shallow Inlet Marine & Coastal Park	fishing	vehicles	static	specialist	local, tourist	Sandy Point	Boat launching notices, Beach access noticeboard
Wilsons Promontory National Park	swimmers, surfers	walkers	static, mobile	general	tourist	Tidal River	Visitor centre, campground noticeboard, carpark notices
Nooramunga Marine & Coastal Park	fishing (boat access only)		static	specialist	tourist	Port Welshpool, Port Albert	Boat launching locations
Mcloughlins Beach - Seaspray Coastal Reserve	fishing	walkers	static , mobile	general	tourist, local	Seaspray	Bait store, Accommodation and caravan parks

PARK NAME	TARGET USER GROUP 1	TARGET USER GROUP 2	STATIC OR MOBILE	GENERAL MGMT OR SPECIALIST	LOCAL OR TOURIST	NEAREST TOWNSHIP/S	AVENUES OF CONVEYING INFO TO USER GROUPS
Gippsland Lakes Coastal Park	walkers	fishing	mobile, static	general	tourist	Lakes Entrance, Lochsport, Seaspray	Boat launching locations, Bait stores, Accommodation and caravan parks
Lakes Entrance - Lake Tyers Coastal Reserve	fishing	dog walkers	static, mobile	general	local, tourist	Lakes Entrance	Bait store, Accommodation and caravan parks, Lake Tyers Tavern
Ewing Morass W.R						Lakes Entrance, Marlo	
Marlo Coastal Reserve	fishing	dog walkers	static , mobile	general	local, tourist	Marlo	Boat launching locations, Bait stores, Caravan/Cabin Park
Cape Conran Coastal Park	fishing	sitting	static	general	local, tourist	Marlo	Boat launching locations, Bait stores, Caravan/Cabin Park
Croajingolong National Park	fishing	hikers	static , mobile	specialist	tourist	Cann River, Mallacoota	Hike notes, Boat launching locations, campsites

Case Study: Analysis of formal and informal beach access tracks at seven locations on the Victorian coast

Using ArcGIS 10.1, seven locations were identified along the Victorian coastline where Hooded Plovers are known to occur (Table 20). Selection was based on known distribution only. Numbers of Hooded Plover records were not used to determine case study areas. Land management was limited to Parks Victoria Land.

Each of the selected seven locations were divided into the following usage categories:

- Areas with high density residential (High Density)
- Areas with limited formal access points (Limited Access)
- Remote areas.

Table 20. The seven locations chosen for case study inclusion, tabulated according to area of coastline, park name and usage category. Included is the aerial photo used and year the image was taken.

LOCATION	PARK NAME	USAGE CATEGORY	AERIAL NAME	YEAR
Far West	Discovery Bay National Park	Remote Area	Nelson	2010
West	Warrnambool – Belfast Coastal Reserve	Limited Access	Warrnambool	2010
Central	Mornington Peninsula National Park	High Density	Sorrento	2009
Central	Mornington Peninsula National Park	High Density	Sorrento	2009
East	Kilcunda – Harmers Haven Coastal Reserve	Limited Access	Wonthaggi	2009
East	Cape Liptrap Coastal Park	Limited Access	Wonthaggi	2009
Far East	Croajingalong National Park	Remote Area	Cann River	2010

Within each of these areas a 5 km stretch of coast was defined to make up a case study area. In locations where multiple case study areas were identified, a minimum of 5km was left between the identified study areas.

Using a number of different satellite images (Google Earth, Bing, Near Maps and Parks Victoria supplied satellite imagery), mapping of roadways, formal tracks and informal tracks was undertaken (see Appendix 9).

In all cases, polylines were developed for the access ways by tracing over the identified path on either the supplied aerial/satellite image or the Bing Base Maps Aerial image supplied through ArcGIS 10.1. When these images were unclear as to whether an access way had been developed or changes were an anomaly in the image, cross referencing with Google Earth and Near Maps was undertaken. In all instances tracks

were started at the beach end of the track and traced back to either the edge of the Parks Victoria estate boundary of the first point of development, whether this be a main road, domestic yard or paddock for example.

Identification of formal access was straight forward as these are sealed or maintained roads and tracks. They are clear within the photographs. These roadways are also mapped and named in a range of directories which make identification straight forward (see Appendix 9).

Informal tracks varied in their "obviousness". In locations where the vegetation was generally undisturbed, tracks showed up easily as the open sand contrasted strongly with the vegetation. This principle was used to map informal tracks through remote case areas and to a less extent the limited access areas. Tyre tracks (parallel lines running through the sand) were also easily picked up and mapped. In areas of high traffic, much of the vegetation has been modified and the above described contrast was not so strong. In these cases the assumption was made that the disturbance to the vegetation was most likely the result of human activity. In remote areas, large areas of vegetation disturbances were attributed to natural events such as rainfall run-off (see Appendix 9).

Identifying the access points along the beach areas was not always obvious. The satellite images show variation in the colour of the sand dunes area and breaks in this colouration were used as an indication of changes to the continuum in the dune face. If a change was identified, close scrutiny of the range of satellite imagery available was undertaken to determine if this change could be linked to an obvious track through the vegetation and made a logical access point from identified tracks. This method may have resulted in overestimating access points in high traffic areas (hard to identify tracks due to extent of damage and points may have been due to weather events however, some access points may have been attributed to natural evens but are in fact man-made) and may have resulted in under estimating access points in low traffic areas as they were attributed to weather or other natural processes.

Once mapped, access ways were allocated as either "formal" or "informal". A way point was taken for the beach end of each point.

Hooded Plover records from BirdLife Australia's database (monitored known breeding sites and additional biennial count locations) were overlaid within the case study areas. This overlay found large variability in the number of individuals that were using the defined stretches of coastline. Table 21 presents the total number of Hooded Plover pairs in the case study areas.

These points were buffered with a 500m radius to give an approximation of the 1km stretch of beach that would make up the approximate territory of the breeding pairs. The plover record was used as the mid-point of the territory.

Within the buffered area, the number of formal and informal access points were tallied to give an indication of the amount of disturbance these birds are being exposed to. In

instances where territories extended beyond the defined 5 km case study area, only access points falling within the defined area were recorded for those birds. These individuals were noted in the results.

Table 21 reveals that areas chosen as being remote based on the number of formal access points upheld this description as both had limited numbers of informal tracks (less than 8). However, when limited access areas were compared against high density access areas it is evident that there are as many informal tracks in these areas, particularly around Harmers Haven where informal tracks outnumber formal tracks to a magnitude of 19. In these 5km areas there can be as many as between 41-58 informal tracks.

Table 21. The number of formal and informal access points within 5km case study areas for the seven selected locations. This includes the number of Hooded Plover breeding pairs occurring in the 5 km study areas.

PARK NAME	USAGE CATEGORY	TOTAL # FORMAL ACCESS	TOTAL # INFORMAL ACCESS	RATIO FORMAL TO INFORMAL	# HP PAIRS
Discovery Bay National Park	Remote Area	0	7	0:7	3
Warrnambool – Belfast Coastal Reserve	Limited Access	5	41	1:8	12
Mornington Peninsula National Park	High Density	15	50	1:3	3
Mornington Peninsula National Park	High Density	3	52	1:17	10
Kilcunda – Harmers Haven Coastal Reserve	Limited Access	3	58	1:19	3
Cape Liptrap Coastal Park	Limited Access	5	47	1:9	1
Croajingalong National Park	Remote Area	2	8	1:4	2

Informal access ways appear to be driven by human desire to access the beaches in as direct a route as possible. In areas of high habitation, the informal tracks can be traced from the back yard of a property, though dune vegetation in the most direct route possible to the foreshore. For adjoining properties, independent tracks have been formed. These may converge further into the dune vegetation, or may remain separate. In other locations, the number of informal tracks appears to be random, possibly reflecting the lack of formal walkways, and so people accessing the beach follow a defined track to start, but then veer off the track as it becomes less clear where it runs. This results in extensive areas of impacted vegetation within the dune systems, and a number of access points along the beach within a short distance, as people randomly come out of the dunes and onto the beach.

In lower human habitation areas, the informal tracks appear to be more defined through the dune vegetation, and more concentrated in access, suggesting that these are more easily followed and regularly used. Again, these appear to have been initially established as direct routes through the dune to the water, in locations where formal tracks are missing. Some informal tracks are obviously used by vehicles and may have been placed because they are away from the main access routes and therefore illegal activity is less likely to be detected. For many of these vehicle tracks, they stem from the formal tracks which allow access into the dune systems.

Tracks within the remote locations all tend to stem from the main access roads.

Further exploration of these access ways is recommended. As the analysis has been undertaken remotely, there is the chance that access points/tracks have been identified that are no longer used (but the impact on the dune vegetation is still evident), or the cleared vegetation is the result of natural processes such as water runoff, rather than man-made access routes. Ground truthing the remote assessment of tracks, as well as confirming the access points on ground is recommended to confirm where human access is impacting on Hooded Plover nesting. Cross referencing the remotely mapped tracks with (internal) Parks maps to confirm which access ways are maintained by Parks Victoria may also be beneficial.

Site by site management considerations

Given the considerable variation in threat profiles across sites, even within the same park, Table 22 makes site by site recommendations for whether managements addressing major threats, namely horses, vehicles, foxes and dogs, are required. Sites with a low ratio of on-leash access to off-leash access are highlighted as those in need of targeted patrols and enforcement, and those with high human pressure (includes all recreational activities) are also highlighted as they will undoubtedly require nest site protection.

Of the 74 sites where we have compiled threat profiles, 82.4% require nest site protection, 54% require dog management, 30% require horse management and 45% require vehicle management (Table 20).

Table 22. Site by site consideration of whether management action addressing major threats are required, namely horses, vehicles, foxes and dogs. Sites with a low ratio of on leash access to off leash access are highlighted, and those with high human pressure (from a range of recreational activities). Assessment of whether site specific (e.g. nest site protection) is indicated.

NAME OF PARK	SITE NAME	HORSE	VEHICLE	FOX	DOGS	LOW LEASHING RATIO	HIGHEST HUMAN PRESSURE	SITE SPECIFIC MGMT REQ
Bay Of Islands Coastal Park	Crofts Bay			Y				Y
Bay Of Islands Coastal Park	Terry's Beach East	Y	unknwn	Y		Y		Y
Belfast Coastal Reserve Coastal Reserve	Killarney Basin Rusty Rocks 1	Y	Y		Y			Y
Belfast Coastal Reserve Coastal Reserve	Killarney Boat Ramp 1 (west of point)							N
Belfast Coastal Reserve Coastal Reserve	Killarney Boat Ramp 2 (east of point)	Y	Y		Y			Y
Belfast Coastal Reserve Coastal Reserve	Killarney Camping Ground West	Y			Y			Y
Belfast Coastal Reserve Coastal Reserve	Killarney Midway	Y			Y	Y		Y
Belfast Coastal Reserve Coastal Reserve	Killarney Old Log Beach 1 (west end)	Y			Y	Y		Y
Belfast Coastal Reserve Coastal Reserve	Killarney Old Log Beach 2 (East End)	Y	Y		Y			Y
Belfast Coastal Reserve Coastal Reserve	Killarney Pelicans	Y	Y		Y			Y
Belfast Coastal Reserve Coastal Reserve	Port Fairy Mills Reef East (Golf Course)	Y			Y	Y but off leash access		Y

NAME OF PARK	SITE NAME	HORSE	VEHICLE	FOX	DOGS	LOW LEASHING RATIO	HIGHEST HUMAN PRESSURE	SITE SPECIFIC MGMT REQ
Belfast Coastal Reserve Coastal Reserve	Port Fairy Mills Reef Far West	Y	Y	Y				Y
Belfast Coastal Reserve Coastal Reserve	Port Fairy Mills Reef West	Y	Y		Y			Y
Belfast Coastal Reserve Coastal Reserve	Tower Hill Gormans Rd West	Y	Y		Y			Y
Belfast Coastal Reserve Coastal Reserve	Tower Hill Rutledge Cutting East 1	Y	Y	Y	Y	Y but off leash access		Y
Belfast Coastal Reserve Coastal Reserve	Tower Hill Rutledges Cutting (mouth)	Y	Y		Y	Y but off leash access		Y
Belfast Coastal Reserve Coastal Reserve	Tower Hill Rutledges Cutting West Pt	Y	Y		Y	Y but off leash access		Y
Belfast Coastal Reserve Coastal Reserve	Tower Hill Towilla East (Seachange)	Y	Y					Y
Belfast Coastal Reserve Coastal Reserve	Tower Hill Towilla West (Seachange)	Y	Y	Y	Y			Y
Belfast Coastal Reserve Coastal Reserve	Warrnambool Levys West 1	Y	Y		Y			Y
Belfast Coastal Reserve Coastal Reserve	Warrnambool Levys West 2	Y	Y	Y	Y	Y but off leash access		Y
Belfast Coastal Reserve Coastal Reserve	Warrnambool Levys West 3	Y	Y		Y	Y but off leash access		Y

NAME OF PARK	SITE NAME	HORSE	VEHICLE	FOX	DOGS	LOW LEASHING RATIO	HIGHEST HUMAN PRESSURE	SITE SPECIFIC MGMT REQ
Belfast Coastal Reserve Coastal Reserve	Warrnambool Levys West 4	Y	Y		Y	Y but off leash access		Y
Bunurong Coastal Reserve	The Oaks							Y
Cape Conran Coastal Park	Marlo Mot's Beach			Y				N
Cape Conran Coastal Park	Snowy River Estuary East			Y				N
Cape Liptrap Coastal Park	South of Six Mile Track			Y		Y	Y	Y
Cape Liptrap Coastal Park	Venus Bay South 1		legal only	Y				Y
Cape Liptrap Coastal Park	Venus Bay South 2		legal only	Y				Y
Eumeralla (Yambuk) Coastal Reserve	Yambuk Estuary East			Y	Y			Y
Gippsland Lakes Coastal Park	Barrier Landing			Y				N
Kilcunda - Harmers Haven Coastal Reserve	Coal Creek Estuary Mouth				Y			Y
Kilcunda - Harmers Haven Coastal Reserve	Cutlers Beach A20 East			Y	Y			Y
Kilcunda - Harmers Haven Coastal Reserve	East 16			Y				Y
Kilcunda - Harmers Haven Coastal Reserve	Far West 16			Y				N
Kilcunda - Harmers Haven Coastal Reserve	Powlett River Mouth East Bank				Y			Y
Kilcunda - Harmers Haven Coastal Reserve	Powlett River Mouth West Bank		legal only	Y				Y

NAME OF PARK	SITE NAME	HORSE	VEHICLE	FOX	DOGS	LOW LEASHING RATIO	HIGHEST HUMAN PRESSURE	SITE SPECIFIC MGMT REQ
Kilcunda - Harmers Haven Coastal Reserve	Waterfall Creek				Y			Y
Kilcunda - Harmers Haven Coastal Reserve	West 16			Y	Y			Y
Kilcunda - Harmers Haven Coastal Reserve	Williamson's Beach West				Y			Y
Kilcunda - Harmers Haven Coastal Reserve	Wilsons Rd 2nd Bay West			Y	Y			Y
Lakes Entrance - Lake Tyers Coastal Reserve	Lake Bunga/Red Bluff			Y	Y			Y
Lakes Entrance - Lake Tyers Coastal Reserve	Lake Tyers Beach				Y		Y	Y
Mornington Peninsula National Park	Alison ave east Rye				Y	Y		Y
Mornington Peninsula National Park	Alison ave west Rye			Y				N
Mornington Peninsula National Park	Gunnamatta Pair 1		legal only	Y		Y		Y
Mornington Peninsula National Park	Gunnamatta Pair 2		legal only	Y				N
Mornington Peninsula National Park	Gunnamatta Pair 3		legal only	Y				N
Mornington Peninsula National Park	Gunnamatta Pair 4		legal only	Y				N
Mornington Peninsula National Park	Gunnamatta Pair 5		legal only	Y				N
Mornington Peninsula National Park	Gunnamatta Pair 6						Y	Y

NAME OF PARK	SITE NAME	HORSE	VEHICLE	FOX	DOGS	LOW LEASHING RATIO	HIGHEST HUMAN PRESSURE	SITE SPECIFIC MGMT REQ
Mornington Peninsula National Park	Heyfield Pair 1 (west side) Rye				Y	Y		Y
Mornington Peninsula National Park	Koonya East		legal only					Y
Mornington Peninsula National Park	Koonya West		legal only		Y			Y
Mornington Peninsula National Park	Miami drive east access				Y			Y
Mornington Peninsula National Park	Miami drive west (extra 2006-2008)				Y	Y		Y
Mornington Peninsula National Park	Moana crt access (east edge)				Y			Y
Mornington Peninsula National Park	Moana crt east (St Andrews)				Y	Y		Y
Mornington Peninsula National Park	Montforts		legal only			Y		Y
Mornington Peninsula National Park	Portsea Franklin rd access (west edge)							Y
Mornington Peninsula National Park	Portsea Franklin rd East (Sphinx rocks end)		legal only		Y			Y
Mornington Peninsula National Park	Portsea Franklin rd west							Y
Mornington Peninsula National Park	Portsea London Bridge (MP)		legal only				Y	Y
Mornington Peninsula National Park	Portsea SLSC east					Y	Y	Y
Mornington Peninsula National Park	Rye Big Rock							N

NAME OF PARK	SITE NAME	HORSE	VEHICLE	FOX	DOGS	LOW LEASHING RATIO	HIGHEST HUMAN PRESSURE	SITE SPECIFIC MGMT REQ
Mornington Peninsula National Park	Rye car park east							Y
Mornington Peninsula National Park	Rye car park west							N
Mornington Peninsula National Park	St Andrews Boags Rocks							Y
Mornington Peninsula National Park	St. Andrews car park east	Y	legal only		Y			Y
Narrawong Coastal Reserve	Narrawong Surrey Estuary East		Y		Y			Y
Narrawong Coastal Reserve	Narrawong Surrey Estuary west		Y		Y	Y		Y
Point Nepean National Park	Sierra Nevada rocks/beach			Y				N
Port Campbell National Park	CLIFTON BEACH			Y				Y
Port Phillip Heads Marine National Park*	Point Lonsdale				Y		Y	Y

Do managers need training?

Beach-nesting birds are extremely sensitive to disturbance and their eggs and chicks prone to crushing. For any area where beach-nesting birds breed, regardless of whether special effort will be made to protect breeding birds, managers need to be aware of the risks that their everyday management of the park or area may pose to the birds.

All management staff, including summer staff and contractors, should at a minimum be able to identify the birds and be informed of their status and threats (achieving this could be as simple as providing brochures to all staff). For parks with a large number of staff, it can be useful to send a memo or post an up-to-date list of active nest locations on a noticeboard.

Management staff often use quad bikes or 4WDs to patrol beaches (and even to access nesting sites to be managed), and if driven above the high-tide mark (which becomes unavoidable if visiting at times of high tide), they run the risk of crushing the eggs, chicks and even the adults. Page 123 provides advice for the use of management vehicles on beaches.

Weed or erosion control, tree planting, collecting rubbish and other activities that involve walking on the upper beach or dunes can also be risky activities if undertaken during the breeding season. Thus, rangers firstly need to be aware that these birds are present and secondly, to plan such activities for the non-breeding season. Where this is not possible, participating staff and volunteers must receive appropriate training in identifying the birds, their nesting behaviours and potential nest locations, and in minimising risks.

It is extremely important that anyone who will be working with the birds, either monitoring or managing them, have the appropriate training. Even the task of putting up signs to flank a nesting site with eggs is of great risk if the person is unaware of the nest's exact location and of the measures that need to be taken if the eggs have already hatched. It is essential that managers follow best practice guidelines for implementing managements (Maguire 2008). Advice for any proposed changes to management techniques should be sought from the relevant experts, for example researchers who specialise in conservation management. Nests have been known to fail when managers have made on-the-spot decisions without seeking proper advice.

The breeding season of beach-nesting birds is often lengthy, and it is likely that staff responsible for protecting nests and chicks will take some leave during this time. It is important that there be a stand-in for these staff and that this person has, or receives, the appropriate training.

Chapter 5 – Monitoring Hooded Plovers

Analysis and consideration of variability in data over time has allowed us to determine the optimal surveying conditions and time frames, and since 2006, alter the prioritisation of monitoring to a focus on collection of breeding data (nest fates and breeding output). This chapter explores population monitoring and monitoring of breeding success, and includes best practice nest monitoring guidelines.

A need for comprehensive monitoring

Monitoring is an essential component of any conservation investment undertaken within the Parks Victoria estate, as well as an important step towards understanding the biodiversity values of the park, their health and whether conservation investment is needed.

For monitoring to be accurate and useful, it is critical that it be repeated and comparable over time. In other words, there needs to be a consistent approach to data collection with not only the same data variables collected over time but these being collected in the same way and attempts made to control for potentially confounding variables. There are instances of having to discount data, sometimes years worth, because of inconsistencies in data collection. This can result in the inability to track changes temporally and spatially, but also amounts to wasted investment in surveys. This can be avoided by reviewing the experimental design of monitoring programs before commencement and also importantly at regular intervals during data collection.

The decision on what should be monitored depends on the objectives. For example, if you are concerned with coastal habitat changes (i.e. dune faces eroding), the presence and abundance of breeding adults during the breeding season will be a good indicator over time as to the integrity and resilience of beach and dune habitat. If you want to determine whether your park has a healthy Hooded Plover population and contributes to the viability of the population, then you will need to monitor breeding output and the most accurate way to do this is to follow nesting attempts through time and document their success or failure. It can be inaccurate to do a count of flying juveniles observed in the park as you do not know the source area from which they fledged – juveniles are capable of dispersing shortly after fledging and moving long distances from their natal territories. A count of juveniles across the coast at the end of a breeding season will be a good indicator of the success of the population, but not a good indicator of the success within a given park.

Monitoring is also critical to adaptively managing the species. Past monitoring has revealed that areas of habitat important to the species can change over time, and that threat profiles can change, both in response to a changing environment and levels of human pressure, but also to management investment (e.g. successful mitigation of a threat).

Population monitoring

Monitoring populations is essential to recognising declines or increases in numbers, changes in distribution or habitat use, and local extinctions or colonisation of new areas. There are several options available for monitoring Hooded Plover population numbers, including monthly, seasonal/quarterly, biannual, yearly or biennial counts.

The frequency of surveying depends on the rate that the population is estimated to change in abundance. If a species is long-lived and adult survival is high, such as the Hooded Plover which can live up to 18 years (possibly more) and where annual adult mortality is less than 10% (Weston 2000), then changes to population size are likely to occur slowly. It would therefore be more efficient to space the survey counts in years rather than months. In this case, yearly or biennial counts should always be carried out at the same time of year to avoid seasonal biases.

For the long-running Hooded Plover biennial counts, November was chosen as the best time for this survey as at this time of year the birds are generally sedentary on their established breeding territories, and by November most pairs have initiated a nesting attempt. This should not only keep the probability of recounting individuals low but if the location of each sighting is recorded, this can inform us of the location of breeding territories along the coast.

For the purposes of surveying the entire Victorian coastline, the coast is divided into 'zones', each headed by a regional organiser to ease the workload of a single coordinator and to provide local advice to volunteers. Within each zone, smaller sections of coast (transects) are allocated to volunteers and the regional organiser ensures there is no overlap in the count area transects. Recent analysis of population count data collected since 1980 has revealed that consistency of areas monitored is crucial to comparing densities over time, and that if sections are missed, or the transect start and end points altered from survey to survey, then it makes it very hard to compare the data (Glover 2009). For the purposes of consistency, specific datasheets are used by count participants when carrying out the survey so that all of the required information is collected in a consistent way, and data is not easily misplaced. Surveying multiple sections of coast needs to take place within as short a period as possible to minimise the likelihood of double-counting individual birds and for this reason a single weekend is nominated for the count.

The extent of potentially suitable habitat covered in biennial counts has varied substantially over time - for instance there was a 21% difference in survey coverage between the 2008 and 2010 biennial counts. Where survey coverage varies between sampling periods, population measures should be adjusted to compensate for the sampling bias or at least interpreted in the context of the variance in sampling. Because of this it is critical to accurately record spatial survey coverage. Having this information

at hand allows a number of statistical options to be explored, the simplest of which is to calculate trends in the density of individuals.

Annual or seasonal surveys

If the species is long-lived, but threats to adult survival are high (for example, predators or vehicle collisions impact the adult population, or habitat has been severely modified by tides or weeds) then more frequent surveys may be necessary, such as annual, biannual, seasonal or monthly counts. Seasonal or monthly counts would be useful for revealing when declines or peaks occur in the population, and how these relate to seasonal variation, particularly as Weston *et al.* (2009) revealed that Hooded Plovers are particular about flocking sites and so surveying during the breeding season and non-breeding season may reveal fluctuations in numbers related to movement to flocking sites. It may be necessary to begin with a finer resolution of monitoring (e.g. monthly) and then evaluate the rate of change, to assess whether this surveying frequency is appropriate.

When Hooded Plovers have been marked with colour bands, flags or engraved leg flags, it can be useful to survey at least on a biannual basis, once during the breeding season to establish the identity of birds at their breeding sites, and once during the non-breeding season to establish the identity of birds within flocks and determine if there are visiting birds from other regions.

If time and resources permit, establishing quarterly surveys would be beneficial:

- August (beginning of the breeding season) to establish how many pairs are on their breeding territories and determine whether nesting has begun
- November (peak of breeding season) to document location of breeding sites and pair identifies
- February (toward the end of the breeding season) to count the ratio of juveniles to adults, although identifying these juveniles is important to determine where they have originated from; if they are not individually identifiable, comparing the

number of known fledglings from your region against the number of juveniles sighted can still be informative[9]

- May (middle of the non-breeding season) to determine which pairs have remained on their breeding territories, to identify flocking sites, and to determine the identity of birds using the park over winter (how far have birds travelled to use the park during winter?)

Colour marking system currently used across the Parks Victoria Estate

There have been three marking systems used for Hooded Plovers within Victoria since the 1990s. These include:

Left to right: Colour bands White over Light Green, Blue over Metal (courtesy Glenn Ehmke); Colour flags Red over Metal, Green over Red (courtesy Geoff Jones); Engraved leg flag 'NS' (courtesy Geoff Gates)

- Colour bands on the lower legs: 3 unique colours with one metal band. Used by Mike Weston in the mid to late 1990s. Very few individuals with this marking system remain on the Victorian coast. A number have lost their colour bands and have either one or two colour bands remaining, or just a metal band. These need to be recaptured for individual identification[10]
- Colour flags on the lower legs: 3 unique colours with one metal band. Used by Phillip Island Nature Park (PINP) from 1993 to 2013. PINP is switching to a single yellow flag with engraved black letters on the upper leg, plus one metal band on the lower leg.
- Engraved leg flags: this is the current marking system used by Mike Weston and BirdLife Australia. A single orange flag is placed on the upper leg and has two black engraved letters unique to that individual. A single metal band goes on the lower leg.

[9] The ratio of juveniles to adults is not a good indicator of breeding success within a park due to the highly dispersive nature of juveniles; they often disperse great distances post fledging, sometimes in a matter of days. Instead this number can be used to more broadly assess how the success of one season relates to another at a population level.

[10] There have been 9 recaptures of birds with incomplete colour band combinations since 2011. Some of these birds have been as old as 17 years old and still breeding. Many have been on the same beach for at least 10-12 years.

Hooded Plovers as an indicator species

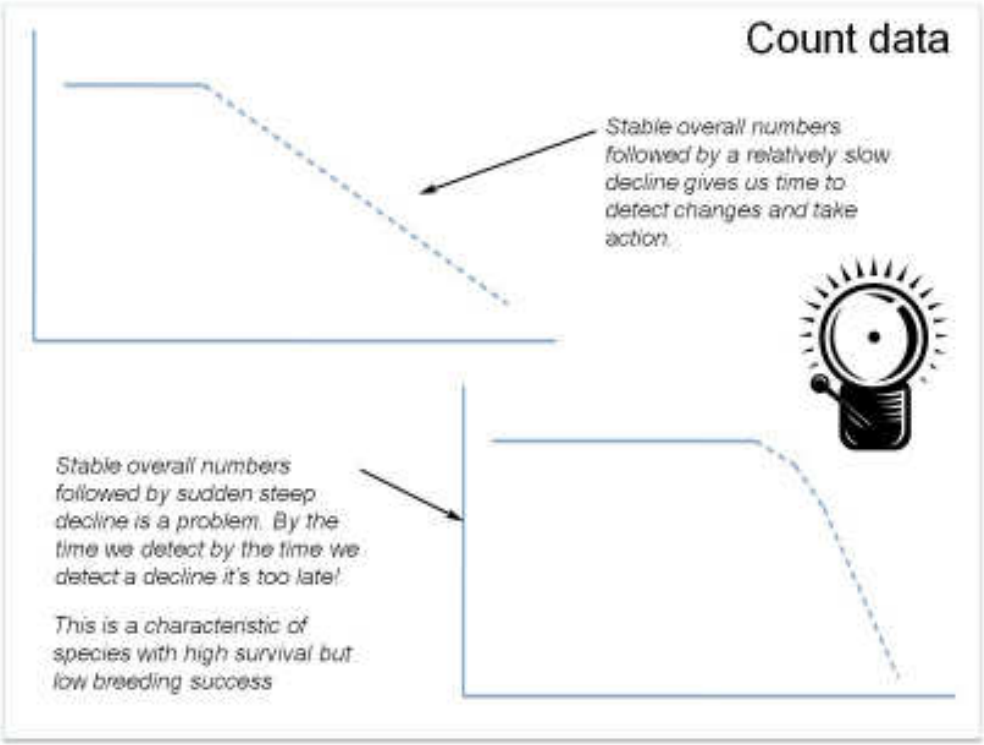
Hooded Plover 'presence' alone is not a good indicator of the 'health' of a particular stretch of coast. While presence can indicate that there is at least food availability and suitable physical habitat to sustain Hooded Plovers at that site, our data reveals that the birds can continue to be present on sites where they have had no breeding success for six to nine years. This indicates that while the physical habitat is assessed as suitable for breeding by the birds, this can be adversely impacted by recreational use and predators so that the birds have repeated unsuccessful nesting attempts over time. We do not have enough of a long-term data set to determine why birds remain on sites where they have had consecutive years of no success, but it may be that an early successful nesting attempt explains the fidelity these birds show to sites, or it may be that territories are such a limited resource that birds remain on these sites despite no success.

Estimates of Hooded Plover population size over time are also not a reliable indicator of the health of the Hooded Plover population because long-lived species with high adult survival are likely to have stable population numbers for a considerable length of time as threats are not impacting adult numbers. Instead if threats are impacting another part of the life cycle such as recruitment into the population, i.e. breeding success, then it is likely that by the time a population decline is detected, it will decline steeply and the problem may be too advanced to remedy (see Figure 26). This is because the adult population has been ageing over the course of the monitoring program, but once these adults start to die off due to old age, the numbers plummet because there have been too few young added to the population over time.

Beach-nesting birds experience threats to their breeding success rather than adult survival, thus, it is essential to monitor breeding success as an indicator of population health. This can be a more difficult task than conducting a population census, but the data can serve multiple purposes, enabling:

- Assessment of the health of the local population
- Assessment of the health of each site
- Determining the dominant threats
- Guiding management priorities and investment
- Documenting compliance, improvements and changes over time

Figure 26. Two patterns of population decline are presented below.



Monitoring breeding success

The best indicator for assessing the health of the coast and/or the health of the Hooded Plover population is to monitor the breeding output/'success' of pairs. However, in order to interpret this information and to recognise which factors influence breeding success, this monitoring needs to be coupled with monitoring of the threats at each site.

BirdLife Australia has established a monitoring program which involves trained volunteers and park rangers regularly visiting breeding pairs over the course of the breeding season, and collecting data on:

- The breeding status of pairs on territories: tracking this from a pair being on territory, courting/mating, making nest scrapes, laying eggs, incubating, hatching, raising chicks, to fledging chicks (i.e. chicks reaching flying age, 5 weeks old)
- Nest failure: when eggs or chicks are lost, dates of loss and any indication of the cause of failure are documented (e.g. fox tracks at the nest; egg shells with beak marks; tide mark over the nest; etc). Remote sensor cameras have been used in recent years at nests with eggs to more accurately assign cause of failure (see pages 41-42)

- Threats on the breeding territory: when visiting the pairs, a quick assessment of threats is conducted to determine the presence of threat types (e.g. observations of predators or evidence that these predators have been present such as tracks or scats; beach users and the type of recreational activity they are partaking in) and the intensity of these threats (so recording actual numbers of threats seen). Because an observer will only be present for a short duration on the site and not observe the full range of threats the site might receive, we also record the density of tracks on the beach as an indicator of the level of use the beach receives (e.g. an observer might visit and see no-one on the beach, but the density of human prints in the sand reveals that this site has had a high visitation recently, indicating that this site does get used by high numbers of visitors).
- Compliance with regulations and nest protection signage: when recording the above checklist of threats, an observer differentiates between dogs on and off the lead, and between people and human and dog tracks inside and outside fenced nesting areas.

A common misconception is that monitoring nesting success of beach-nesting birds will increase risks to the birds, for example: "We don't want to disturb the birds as they suffer enough disturbance", "It is too risky to the birds and will result in more nest failures" and "Approaching the nest will lead predators to the nest". There are definite risks associated with monitoring threatened birds, which is why there are strict protocols for actively searching for nests and for monitoring nests and chicks. BirdLife Australia's protocols are based on the extensive research of Dr Mike Weston into the mechanisms of disturbance to Hooded Plovers. BirdLife Australia has used these protocols for seven consecutive breeding seasons and there is no evidence of reduced success related to higher levels of monitoring, nor was the risk of predation different between frequently visited and managed nests versus infrequently visited and unmanaged nests.

Considerations when utilising volunteers in monitoring

Volunteers and rangers participating in monitoring Hooded Plovers are advised to follow BirdLife Australia's best practice monitoring guidelines (as per Maguire 2008; Appendix 10).

Table 23 provides a list of volunteer groups currently assisting with monitoring of Hooded Plovers on the Parks Victoria estate. Training of monitors is critical to minimising risks to the birds and it can be useful to designate a contact person within a given park to liaise with volunteers to ensure they have been trained, and over time, that refresher courses are offered and the value of this training and monitoring protocols are not forgotten. Training of monitors is also implicit to ensuring consistent data collection, as untrained observers can not only overlook key information but can also misinterpret this data once collected. The latter can result in the formation of inaccurate conclusions leading to ill informed, and sometimes catastrophic, decision making.

Table 23. The groups directly engaged in BirdLife Australia's Beach-nesting Birds Program according to which parks they are active within.

PARK NAME	GROUP ENGAGED IN HP PROJECT
Discovery Bay Coastal Park	Portland Field Naturalists, Friends of the Great South West Walk
Narrawong Coastal Reserve	Friends of the Surry
Eumeralla (Yambuk) Coastal Reserve	Friends of the Hooded Plover Far West Vic
Yambuk F.F.R.	Friends of the Hooded Plover Far West Vic
Belfast Coastal Reserve Coastal Reserve	Friends of the Hooded Plover Far West Vic
Bay Of Islands Coastal Park	Friends of the Bay of Islands Coastal Park
Port Campbell National Park	Friends of the Bay of Islands Coastal Park
Great Otway National Park	Friends of the Hooded Plover Surf Coast, Friends of the Hooded Plover Otway Coast
Eagle Rock Marine Sanctuary	Friends of the Hooded Plover Surf Coast, Angair
Elliot River - Addis Bay Coastal Reserve	Friends of the Hooded Plover Surf Coast, Angair
Lonsdale Lakes W.R	Friends of the Hooded Plover Bellarine
Port Phillip Heads Marine National Park	Friends of the Hooded Plover Bellarine
Point Nepean National Park	Friends of the Hooded Plover Mornington Peninsula, Spiffa, Nepean Conservation Group
Mornington Peninsula National Park	Friends of the Hooded Plover Mornington Peninsula, Spiffa
Punchbowl Coastal Reserve	Friends of the Hooded Plover Bass Coast
Kilcunda - Harmers Haven Coastal Reserve	Friends of the Hooded Plover Bass Coast
Bunurong Coastal Reserve	Friends of the Hooded Plover Bass Coast
Cape Liptrap Coastal Park	Friends of Venus Bay Peninsula, Friends of the Hooded Plover South Gippsland
Shallow Inlet Marine & Coastal Park	Friends of the Hooded Plover South Gippsland
Wilsons Promontory National Park	Friends of the Prom
Nooramunga Marine & Coastal Park	Friends of the Hooded Plover South Gippsland
Mcloughlins Beach - Seaspray Coastal Reserve	BirdLife East Gippsland
Gippsland Lakes Coastal Park	BirdLife East Gippsland
Lakes Entrance - Lake Tyers Coastal Reserve	BirdLife East Gippsland
Ewing Morass W.R	BirdLife East Gippsland
Marlo Coastal Reserve	BirdLife East Gippsland
Cape Conran Coastal Park	BirdLife East Gippsland
Croajingolong National Park	Individual volunteers

My Hoodie Data Portal

The My Hoodie Data Portal (http://portal.myhoodie.com.au/) was created to facilitate the monitoring and management of Hooded Plovers across Australia (see user guide, Appendix 11).

The current portal serves the purpose of entering observations of Hooded Plovers and threats at beaches known to support Hooded Plovers, and assists the team at Birdlife Australia and land managers, in particular Parks Victoria rangers, to manage the welfare of the birds in real time.

The portal offers significant benefits to the birds and on-ground conservation efforts, enabling data to be accessible in real time (critical to timely nest or chick protection) and for correspondence via email and phone to be significantly reduced when the portal is broadly used by volunteers and land managers.

The portal can be used to:

- Interactively view data to see what the Hooded Plover pairs are currently doing on a particular beach, i.e. are they sitting on eggs, raising chicks, flocking, are they absent from that site, have they not been monitored for many months?
- Decide which pair to visit or which pair needs management attention.
- Update nesting status of pairs and share observations with land managers and other volunteers in real time.
- Enter BirdLife Australia "Pair Monitoring Forms" quickly and easily online (these are analysed and contribute to better understanding of population viability and conservation investment).
- Record observations of banded birds.
- Notify those who carry out nest and chick site protection of management issues.
- View and download excel reports all survey data for the year or summaries of all nesting activity for a season.
- View and upload photos taken during observations.

A working example of how the portal benefits communication and on-ground action

In September 2012 the data portal was launched and volunteers on the Mornington Peninsula took up the portal swiftly. Seventy days after its launch, there were 270 observations entered by 17 different observers. In its first season of use, there were more than 3700 observations entered by over 120 users.

Volunteers and rangers[11] use it to enter their sightings during the breeding season and to enter management alerts for new nests that are found in vulnerable positions. The portal is used to guide decision making on which pair to visit (i.e. they will make a visit to a nest with eggs when it is due to hatch to determine hatching success; they will visit a pair that hasn't been checked for at least a fortnight to see if they are showing signs of nesting).

The ranger responsible for Hooded Plover monitoring and management response checks the system to follow the outcome of nests and chicks, and to guide his visits also. There is a group email to all volunteers put together each Friday which assists with setting priorities for visiting on the weekends. The ranger can check the portal on that day to get the most up-to-date information for this email and can disseminate this information to a broader group, including rangers who will be on duty during the weekend. He can use this to determine which pairs might be due to hatch or which sites need urgent fencing or signage prior to a busy weekend. This can all occur without having to trudge through a series of emails for the week or chase up information from volunteers. When dealing with something like a Hooded Plover nest, the situation can change so quickly and relaying information to the right person rapidly was once a major obstacle. Previously, a volunteer might have emailed or rung rangers and not got through, or might have thought that they were already aware of the nest and just reported it on their data sheet that they put in the post. It could take days or even weeks for a response with a busy weekend/s in between.

A ranger or a qualified volunteer can respond to a management alert by going out and putting up a fence, and so he can then update the portal to show that this is now all in place. This saves multiple people contacting the rangers, BirdLife Australia and the Friends group about the same issue and trying to chase up whether management has gone in. It greatly eases one-to-one communication, is a more efficient way of relaying data and therefore uses less valuable ranger time, enabling better funneling of resources into the on-ground actions that benefit the species.

At any point within the season, Parks Victoria can access summaries of monitoring activity and know which volunteers are most active, the number of pairs breeding and the nesting success so far. This greatly assists with reporting and also cuts down on the time that rangers need to invest in collating emails and keeping their own data files to manually track this.

Adaptive Management – the necessity of monitoring

Monitoring breeding success and threats at sites enables us to identify the effectiveness of management investment, and thus to adjust (or discard) management strategies to

[11] Currently, Parks Victoria staff are unable to access the site effectively on work computers due to limitations of current computer software. Rangers are currently updating the portal at home out of work hours, which is unsustainable.

bring about improvements in conservation of the species. While many management strategies have been tested and proven, often the finer details of manipulating the configuration of fencing to suit the morphology of a given site or wording on signage to suit a local audience for example, are revealed through trial and error over time. Reviewing public compliance and opinions of management can greatly improve their long-term effectiveness. Threat profiles of sites can change radically over time, where new threats may arise or become more dominant in terms of relative impact. It is important to track the intensity of threats over time and collect evidence on causes of nest failure so as to detect any such changes, and act in a timely manner to mitigate these arising threats. Current remote sites may not stay remote over time, particularly if new coastal developments arise or new infrastructure facilitates easier visitation. Furthermore, the habitat of some beaches may degrade over time, and result in shifts in the occupation of sites by birds. This may result in birds breeding in areas that have off-leash dog access or lack appropriate regulations to mitigate human impacts, while past areas suitable for breeding that are protected by regulations become uninhabited. This presents the need for management to be adaptive but also to have the capacity to do so quickly. Here the idea of an interim conservation order may be an effective solution.

The impacts of climate change are currently poorly understood, and it is likely that Hooded Plover habitat will be lost in future. There are areas of the coast with infrastructure and development in the primary dune leaving little space for retreat of the dune system. Here there may be little that can be done to ensure habitat resilience. The aspect of the beach and width of dune habitat will be important predictors of how well beach habitat will persist. Ensuring that we tackle weed invasions in areas with high value to the species and potential for dune retreat over time will be a priority in the immediate future to minimise the extent of future habitat loss via rising sea levels.

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