# Hooded Plover *Thinornis rubricollis* Husbandry Manual


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# 1 Introduction

## 1.1 Introduction to the Species

The Hooded Plover *Thinornis rubricollis* is an endemic Australian shorebird. Unfortunately, the Hooded Plover's preferred habitat of sandy ocean beaches in south-eastern Australia brings it into conflict with human recreational users, and elements of it's life-history make it poorly adapted to raise young in an environment subject to frequent access and disturbance (Maguire *et al.* 2014). Declines in population and range continue to be observed in the eastern subspecies. The western subspecies is less well known, but is believed to also be declining (Garnett *et al.* 2011).

There are two allopatric populations. An eastern subspecies, *T.r.rubricollis,* in the southeastern states of Australia, and a western subspecies, *T.r.tregallasi,* in the southwest of Western Australia (Garnett *et al.* 2011). The south-eastern population inhabits wide sandy ocean beaches backed with sand dunes, especially beaches where seaweed is prevalent, and is rarely found inland. The south-western population breeds on coastal or inland salt lakes, but spends the non-breeding season at coastal lakes (Garnett *et al.* 2011). Its closest relative and only congener is the Endangered Shore Plover *Thinornis novaeseelandiae* of New Zealand (Christian *et al.* 1992; Christidis and Boles 2008).

## 1.2 History in Captivity

The only known captive population of Hooded Plover was established at the Adelaide Zoo, South Australia, in 1993 as part of the Australian Native Bird exhibit there, because of a desire by staff at the time to increase avian variety at the zoo especially with species of local relevance. Founded initially from eggs collected from the wild population on Kangaroo Island, South Australia, and hatched and reared at the Zoo, the population was supplemented by both wild-born, captive-raised individuals, and captive-born and raised individuals. A total of nineteen Hooded Plovers have been accommodated at the zoo to date, but no more than seven at one time (L Ellis 2014, pers. comm.) They are reportedly easy to manage (C Romer 2014, pers. comm.) Problems with bumblefoot and behaviour have been experienced (L Ellis 2014, pers. comm.; M Singor 2011; M Weston 2014, pers. comm.) Only two females currently remain and the zoo has no plans to augment the population further (C Romer 2014, pers. comm.)

To try and reduce chick mortality Phillip Island Nature Park research staff trailed experimental predator exclosures (Baird and Dann1999). While hatching success improved significantly there was no improvement in fledging success and there were some losses of adult birds to predation (Dann unpub. data). Also on Phillip Island a small number of birds were taken in to care following an oil spill that reached breeding beaches in 2008 (Weston *et al.* 2008). In 2011, an unsuccessful attempt at hand rearing was made after Birds Australia staff at Bremer River, Western Australia, rescued a clutch of eggs at risk from flooding. All three rescued eggs hatched, but

only one bird survived longer than 24 hours, dying on the 5th day post hatching (Singor 2011).

No other attempts to raise the Hooded Plover in captivity are known, although the Healesville Sanctuary did propose establishing a captive breeding population in the early 1990's (Weston 2003). There are no current plans for captive breeding (L. Lumsden 2014 pers. comm.)

## 1.3 Value of the Hooded Plover for education, conservation and research

The southeastern Hooded Plover populations preference for ocean beaches has brought them into conflict with recreational activities of humans. In particular, the adult's trait of leaving the nest when disturbed by perceived threats leaves the eggs liable to overheating, accidental damage and predation (Schulz and Bamford 1987; Buick and Paton 1989; Dowling and Weston 1999; Baird and Dann 2003; Weston 2003; Weston and Elgar 2005a, 2005b, 2007). The result is an extremely poor breeding success rate and a steady decline in population (Weston 2003; Maguire *et al.* 2014).

Captive breeding and reintroduction provides an opportunity to provide source populations to augment the wild population until improved management of threats enables sustainable natural population levels (Powell and Cuthbert 1993; Powell *et al.* 1997). Many of the threats to the species result from human activities (Dowling and Weston 1999, Weston 2003, Williams et al. 2009, Weston et al. 2012, Maguire *et al.* 2013). Populations in zoological institutions can be used as an educational resource to improve public awareness of the threats to the species, and changes in public behaviour that can have a beneficial impact.

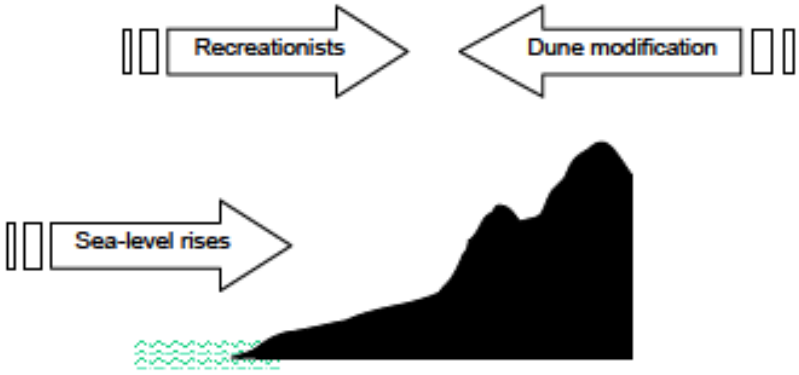


Figure 15.2. Diagrammatic representation of the "habitat squeeze" on Hooded Plover nest sites. Arrows show the suspected influence of different processes on nest site selection.

**Figure 1.1: The Hooded Plover as a victim of habitat squeeze** (Weston 2003)


**Figure 1.2: Example of a Hooded Plover interpretive display at Adelaide Zoo**
(Photo: M Honeyman)

# 2 Taxonomy

## *2.1 Nomenclature*

Class: *Aves*
Order: *Charadriiformes*
Family: *Charadriidae*
Genus: *Thinornis*
Species: *rubricollis*

## *2.2 Subspecies*

*T. rubricollis rubricollis*
*T. rubricollis tregellasi*

## *2.3 Recent Synonyms*

*Charadrius rubricollis* (Marchant & Higgins 1993)
*Charadrius cucullatus* (Christidis and Boles 2008)

## *2.4 Other common names*

Hooded Dotterel or Hooded Dottrell (Marchant & Higgins 1993)

## *2.5 Discussion*

The taxonomic position of the Hooded Plover in relation to other Charadriidae is not resolved (Christian *et al.* 1992; Christidis and Boles 2008). The eastern and western subspecies were recognised in Mathews (1913-14), Baker-Gabb and Weston (2006), Garnett *et al*. (2011). Not all authorities recognise the subspecies (Christidis and Boles 2008).

# 3 Natural History

Hooded Plovers are socially monogamous and both sexes exhibit high levels of parental care (Weston 1998; Weston 2003; Weston and Elgar 2005a, 2005b, 2007). They are sedentary and exhibit high site fidelity. In the breeding season, breeding pairs of the eastern subspecies may remain on the breeding territory, or form small flocks with other birds, usually relatively near to the breeding territory (Weston 2009). The western subspecies appears to migrate seasonally from breeding territories at inland salt lakes to the coast (Weston and Elgar 2000).

The Hooded Plover has an extended breeding season, from July to April, although breeding most often occurs between August and March and is believed to be dependent on climatic and tidal conditions (Weston 2003; Baird and Dann 2003; Maguire *et al.* 2014). Hooded Plovers generally lay two or three eggs, occasionally just one or as many as four (Weston *et al.* 1998; Baird and Dann 2003).

One egg is laid approximately every 48 hours and, once the full clutch is laid, the birds incubate for 26-31 days (Newman 1986; Bransbury 1991; Weston and Elgar 2005). Chicks are nidifugous. Fledging takes approximately 35 days (Newman 1986). The chicks continue to be brooded for the first two weeks, as they are unable to independently thermoregulate. The chicks will run to cover in response to threats, often on warning calls from the parents, and crouch until the perceived threat is gone and the parents call them out from hiding. They feed mostly at the water's edge and along the wrack line amongst beach-cast seaweed (Weston 2003).

Birds are aggressively territorial to intraspecifics and interspecific intruders. Even fledglings may be evicted from the territory, especially if there is still time in the season for additional nesting attempts (Teoh and Weston 2002; Weston 2003). Theoretically each pair can have up to seven nesting attempts per breeding season. However, the average observed nesting attempts per season is 1.5 (Baird and Dann 2003). The cues for laying are not well understood (Maguire *et al.* 2014).

Their nest defence strategy depends on the threat. For avian predators the adults will stay on the nest and flatten themselves over the brood, and may attack aggressively. For other non-avian terrestrial threats, the most common strategy is to leave the nest and stay distant from the eggs, until the predator leaves and it is safe to return (Weston 2003). Other defence strategies include false brooding to distract the threat away from the bird's nest, and injury feigning once the young have hatched (Bransbury 1991, Weston 2000, 2003). The nest absence defence strategy is a key cause of brood loss through overheating or predation / damage (Weston and Elgar 2005, 2007).

## *3.1 Morphometrics*

Hooded Plovers are not sexually dimorphic and sex cannot be determined from field observations or in the hand. A molecular sexing technique has been used (Weston *et al.* 2004). Adult birds are grey (upperparts and wings) and white (underparts and underwing), with a distinctive black head, red orbital ring, and broad white nape. This nape is the key field diagnostic feature. The short red bill has a black tip. Both sexes are similar. Juvenile birds are duller versions of adults with grey head, orange eye ring and mottling (Weston 2003).

Similar species include the Red-capped Plover, Double-banded Plover and in flight, the Ruddy Turnstone. The chicks, in particular, can cause confusion because of their less boldly marked plumage. However, the Hooded Plover is distinguished from all other small shorebirds in Australia by the broad white nape present at all ages (Marchant and Higgins 1993; Weston 2003).

### 3.1.1 Measurements

Adults weight 79-110 grams (mean 100.3 grams), fully grown juveniles 85-95 grams (mean 89.6 grams) (Marchant and Higgins 1993). Birds from the western population have statistically significant differences in bill and tarsus (longer than eastern birds) (Marchant and Higgins 1993).

**Table 3.1 Summary of mean measurements from skins**
(D.I.Rogers examined skins in the Museum of Victoria, The H L White Collection, the Wester Australian Museum and the South Australian Museum)

| All measurements in mm | Wing | Tail | Bill | Tarsus |
|---|---|---|---|---|
| Eastern Male | 143.2 | 62.4 | 17.7 | 26.0 |
| Eastern Female | 144.4 | 62.1 | 17.6 | 26.2 |
| Western Male | 144.0 | 61.2 | 18.2 | 27.1 |
| Western Female | 144.2 | 61.8 | 18.5 | 26.2 |
| Eastern immature / juv. | 140.4 | 60.3 | 17.1 | 25.9 |
| Western immature/ juv. | 142.0 | 59.9 | 18.0 | 26.3 |
| Eastern (Tas.) all | 141.1 | 61.8 | 17.4 | 25.8 |

## *3.2 Distribution*

The Hooded Plovers is endemic to Australia. The population is currently estimated at 5500 individuals: 3000 in the eastern subspecies and 2500 in the western subspecies (Garnett *et al.* 2011). There are two allopatric populations. *T.r.rubricollis* in the south east of Australia, and *T.r.tregallasi* in the south west of Western Australia (Garnett *et al.* 2011). There are no records of interchange between the two populations, the distance between the populations exceeds the longest known movements (Weston *et al.* 2009).


**Figure 3.1: Hooded Plover *Thinornis rubricollis* distribution**
From Maguire *et al.* 2014. Blue shading: Eastern (nominate) *T.r.rubricollis*, Red shading: former range of *T.r.rubricollis*, Green shading: western *T.r.tregallasi*, Text: Current (2014) conservation status at the State level

## *3.3 Habitat*

The eastern and western ssp. exhibit distinct habitat choices.
The eastern populations select ocean surf beaches, preferring wide beaches with wide wave-wash zone backed by dunes with large amounts of beach-washed seaweed (Weston 2003). Less often they utilise tidal bays and estuaries, rock platforms or small beaches in lines of cliffs where the beach is backed by dunes (Hewish 1989). In South Australia they have also been recorded on coastal saline lagoons and lakes (Marchant and Higgins 1993). The presence of a significant wrack line (beach washed seaweed) appears to be a key requirement, as this is an important foraging substrate for invertebrates (Weston 2003). Breeding territory is typically an approximately 1km stretch of beach. The birds will forage on the beach at all levels but predominantly at the water's edge and along the wrack line. Nesting habitat can include dune blowouts, foredune, and the edge of estuaries and anywhere on the beach above the high tide mark. Habitat choices are currently being modelled and are expected to show that habitat choices constrain the available suitable habitat for the eastern ssp. (G Maguire 2014 pers. comm.)
The western populations utilise salt lakes, significantly inland, and occasionally coastal brackish lagoons, dispersing to the coast in the non-breeding season (Storr 1965; Weston 2007).

## *3.4 Conservation Status*

### 3.4.1 International

IUCN Red List: Listed as Vulnerable (BirdLife Australia 2014)

### 3.4.2 National

Listed as a Marine species under the Environment Protection and Biodiversity Conservation Act 1999 (Department of Environment 2014).

### 3.4.3 State

New South Wales: Listed as Endangered under the Threatened Species Conservation Act 1995. (Department of Environment 2014).

Victoria: Listed as Vulnerable under the Advisory List of Threatened Vertebrate Fauna in Victoria 2003; listed as Threatened under the Flora and Fauna Guarantee Act 1988. (Department of Environment 2014).

South Australia: Listed as Vulnerable under the National Parks and Wildlife Act 1972. (Department of Environment 2014).

Tasmania: No conservation status listed, although suggested for possible listing (Bryant 2002)

Western Australia: No conservation status listed (Department of Environment 2014).

### 3.4.4 Discussion

The most recent detailed review of the conservation status of the Hooded Plover was the Action Plan for Australian Birds 2010 (Garnett *et al.* 2011). The 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 evidences the increasing concern about the Hooded Plover as research has been carried out and populations have continued to decline in recent decades. In Victoria there has been an estimated decline of 13% between 1980-1992 (Weston 2003). The population on Phillip Island was estimated to have declined by 58% between 1981-1997 (Baird and Dann 2003).

## *3.5 Diet in the Wild*

Hooded Plovers eat a wide variety of invertebrate prey and occasional plant matter (Schulz *et al.* 1984; Weston 2003; Weston 2007).

**Table 3.2 Summary of diet observations** ((1) Schulz et al. 1984, (2) Weston 2007)

| Habitat | Food / Prey | Identification | Reference |
|---|---|---|---|
| Beach, Victoria | Gastropoda | Patelloidae, Coxellia | 1, 2 |
| | Polychaeta | Not identified | 1, 2 |
| | Crustacea | Amphipoda, Isopoda | 1, 2 |
| | Insecta | Coleoptera, Hemitera, Diptera | 1, 2 |
| | Plants | Turions, seeds, algae | 1 |
| Salt lake, WA | Gastropoda | Coxiella spp. | 2 |
| | Crustacea | Not identified | 2 |
| | Plants | Seeds | 2 |

## *3.6 Longevity*

### 3.6.1 In the Wild

Adults have high survivorship with an annual survival rate of 90.7%. Generation length is estimated at approximately 10 years (Weston 2003). Sexual maturity is estimated at 1.7 years (Baird and Dann 2003) although earlier breeding has been reported (Weston 2003, Dennis and Ball 2013). The longest duration between banding and recapture of a recorded individual is 16 years (ABBBS database accessed online http://www.environment.gov.au/cgi-bin/biodiversity/abbbs/abbbs-search.pl).

### 3.6.2 In Captivity

The maximum age of wild born birds raised at Adelaide Zoo was 10 years, 8 months, 9 days. The maximum age of captive born birds raised at Adelaide Zoo is 11 years, 4 months and 11 days (bird currently in captivity, age at 21 March 2014) (L Ellis 2014 pers. comm..)

### 3.6.3 Techniques Used to Determine Age in Adults

There are no reported techniques to determine age in adults.

**Figure 3.2: Juvenile Hooded Plover** (Photo: A Fletcher)

# 4 Housing Requirements

## *4.1 Housing Design Principles*

### 4.1.1 General

Two types of housing are described below: those whose primary aim is public exhibition, and those focussed on captive breeding for re-release to the wild. Currently Hooded Plovers have only been exhibited at Adelaide Zoo. However in the future, if the species continues to decline, captive breeding and release has the potential to become an important element of the recovery program (Powell et al. 1993, Powell et al. 1997, White and McMaster 2005) and so additional examples that apply are described here based on successful programs for other small-medium sized plover species.

In either instance Hooded Plover enclosures must be designed to provide the species with an environment that meets it's physical, behavioural and social needs, so that the birds can maintain optimal physical and psychological fitness. This should replicate key features of the Hooded Plovers natural environment as much as practicable (Duncan and Hawkins eds. 2009, AZA 2014).

### 4.1.2 Construction

Aviaries should have a secure structural framing suitable for the environmental conditions (wind loading) expected for the area (Collen 2014). A steel frame is easier to keep clean than a timber frame, but either can be used (Duncan and Hawkins eds. 2009).

Metal (or plastic mesh) for the sides must be robust and sufficiently small to prevent the birds escaping and pests gaining entry, 10-20mm mesh would be suitable. Chicken wire is adequate, and is used at Adelaide Zoo (coated with a weather proof treatment), but square welded mesh or similar is more robust (Collen 2014, White and McMaster 2005). In any case there should be no sharp edges and the design should facilitate ease of cleaning. A plastic coating over the wire or mesh makes it easier to clean (Duncan and Hawkins eds. 2009)

Hard floors should be avoided, as they increase the likelihood of bumblefoot, which is common in captive shorebirds (Collen 2014, AZA 2014, L. Rowell 2014 pers comm.), but the underfloor beneath the substrate should be secure to prevent burrowing animals accessing the enclosure, should facilitate drainage, ease of cleaning, and periodic removal and replacement of the substrate (Collen 2014, Duncan and Hawkins eds. 2009).

### 4.1.3 Security

The exhibit needs to be secure, so that the birds cannot escape but also so that predators cannot access the exhibit. The birds at Adelaide Zoo have been subjected to egg predation (suspected to be by mice) and a breeding pair was lost following a rat attack in 2004 (L. Ellis 2014 pers comm.). Rodent traps are deployed at the current enclosure (pers. obs) and are good practice in general, as a secondary defence after good enclosure design and construction. Other features to mitigate predation risk include overhead netting or cage (if the birds are un-flighted and the exhibit is open topped), and secondary electric fence, and fencing extending at least 300mm below

ground to deter terrestrial predators including those that would dig into the exhibit such as foxes. (AZA 2014, Collen 2014) A double door arrangement should be used to permit keeper access while preventing the birds from escaping (AZA 2014), and at Adelaide the access passageway has a bamboo screening against the exhibit side to minimise stress to the birds as keepers enter the exhibit (pers. obs.).
As well as being secure the birds must feel secure. There is anecdotal evidence that Hooded Plovers are relatively sensitive to stress with birds being captured for veterinary care dying from shock during relatively short trips to the treatment facility (P.Dann pers comm.). While this appears not to have been a significant issue with the captive bred birds it is prudent to include some screening / barrier between the public facing sides of the exhibit and public access areas (AZA 2014).

### 4.1.4 Light

The intensity and duration of light should follow what Hooded Plovers would experience in their natural range as far as possible (AZA 2014).

### 4.1.5 Ventilation

The design of the exhibit should facilitate a free flow and regular exchange of air so as to maintain acceptable temperature and humidity and reduce the risk of fungal spores developing (AZA 2014).

### 4.1.6 Zoo Exhibits

Plovers and other shorebirds are held at a number of institutions around the world, but Adelaide Zoo is the only location to house Hooded Plover. The captive population at Adelaide Zoo has been successfully housed in aviaries within the Australian Native Birds exhibit since 1993. Two aviary types have been used at Adelaide, the ‘Coastal Aviary’ and the ‘Native Bird Aviary’. The size and arrangement of each is each is similar, the native bird aviaries are ~2m in height while the coastal aviary is taller, ~4m in height (L.Ellis 2014, pers. comm.).

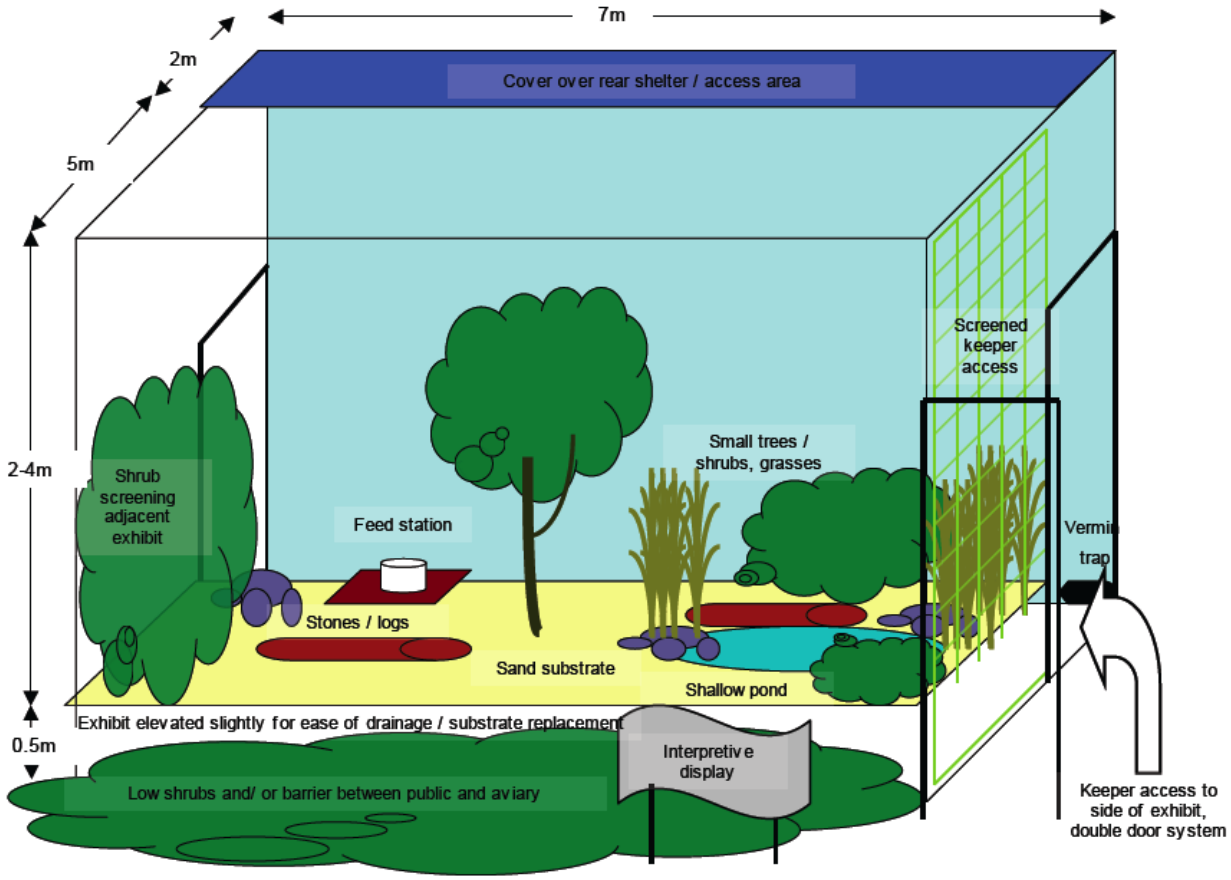


**Figure 4.1: Schematic of Hooded Plover aviary typical of Adelaide Zoo facilities**

**Figure 4.2: Adelaide Zoo coastal bird aviary (has previously housed Hooded Plovers)** Photo: M Honeyman

**Figure 4.3: Adelaide Zoo Australian native bird aviary currently used to house Hooded Plovers.** Photo: M Honeyman

The Wader's Estuary exhibit at the Living Shores Zoo in the UK is possibly the 'state of the art' in Shorebird exhibits. This is a large exhibit (35m x 20m) within a much larger seabird aviary allowing significant space and height for flying below a netting roof over the entire zoo. It attempts to represent a realistic estuary environment for the shorebirds species held. The large fresh water pool has a continuous supply of running water and a wave machine to provide naturalistic water movement at the waters edge where there is a sandy beach (L. Rowell 2014, pers. comm.).

**Figure 4.4: Waders Estuary exhibit, Living Shores, Torquay UK.** Photo: Living Shores

**Figure 4.5: Waders Estuary exhibit, Living Shores, Torquay UK.** Photo: Living Shores

### 4.1.7 Flight Pens for Captive Breeding and Release

For birds intended to be captive bred for release, to augment wild populations under threat, there is a more acute need to acclimatise the birds to their natural environment and provide improved opportunity to practice the behaviours that will be necessary in the wild. Large pre-release flight pens have been used for both the Snowy Plover captive breeding and release program in North America and Canada, and Shore Plover program in New Zealand (Collen 2014, Powell et al. 1997, White and McMaster 2005).

The Shore Plover pens replicate small sections of coastline, from an area of nesting habitat above the water line, down to the water's edge. Multiple pens are provided each holding a single breeding pair. The pens are 10 metres square in area and 4m high. 50-67% of each pen is 'shore', on either side of shallow flowing water, at a depth that the birds can wade in safely. Having flights adjacent to each other has been found to stimulate territorial and breeding behaviour. The pens are big enough to enable the birds to space themselves away from neighbours to limit aggression. Dividing walls between each 10m x10m pen are made from netting that can be retracted to make larger pens for non-breeding flocks / large groups of juvenile birds (Collen 2014).

**Figure 4.6: Shore Plover aviary at Peacock Springs, New Zealand** (Collen 2014).

The Piping Plover captive rearing program Minnesota used pens 9.1m x 6.1m for checks post fledging, on a sandy beach, with 1m of the pen extending into the water

(Powell et al. 1997). The Snowy Plover captive rearing program in Saskatchewan has employed similar large (24m x 24m) flight release pens fabricated from 2"x6" timber and ¾" polyethylene bird netting, that straddle a drainage dyke providing access to water on two sides (White & McMaster 2005).

**Figure 4.7: Snowy Plover pre release flight pens** (Photo: D Krughoff).

## 4.2 Holding Area Design

For short-term holding areas meeting the requirements of DEPI Victoria (Table 4.1) would be an appropriate minimum holding area– 5m x 4m x 2m high for no more than four birds. A shallow pool of at least $5m^2$ should be included (Department of Environment and Primary Industries 2001). A soft substrate should be provided, and somewhere where the birds can find shelter or feel secure. (AZA 2014).
In the New Zealand Shore Plover program the short term / quarantine holding area 'for one bird or small groups' the pen size is set somewhat larger at 9m x 5m x 1.5m high (Collen 2014). If natural light cannot be provided then the ability to mimic the photoperiod of the main exhibit should be provided (AZA 2014).

## 4.3 Spatial Requirements

In the wild Hooded Plovers are largely active on the ground, foraging by sight at all levels of their beach habitat (Buick and Paton 1989). To enable normal behaviour sufficient room should be provided for the birds to run around and forage. Hooded Plovers do not fly often (Buick & Paton 1989) but may fly in reaction to threats (Schulz 1987), and the exhibit should have sufficient height and space to enable the birds to fly without the probability of striking the exhibit sides. The aviary should include a roof at least 2m high ((Department of Environment and Primary Industries 2001, White and McMaster 2005) although greater heights have been also been recommended for plover species (3-4m, AZA 2014, Shore Plover). The aviaries at Adelaide Zoo are approximately 7m x 7m (including shelter space to the rear of the

exhibit), with the 'habitat' space being approximately 7m x 5m (35m2 in total) (author's measurements). These enclosures have housed a maximum of seven birds (including juveniles) at any one time, though this was only for two seasons, and a lower number has been more usual. Both 2m and 4m high aviaries have been used successfully at Adelaide Zoo (L. Ellis pers. comm.).
In Australia, the Victorian Government Department of Environment and Primary Industries (DEPI) specifies minimum requirements for housing plovers in the State of Victoria. This is the minimum size for an exhibit and should not be assumed to be suitable for a breeding enclosure. No other State in Australia currently prescribes a minimum captive housing size, generally just the requirement that a sufficient size enclosure for the welfare of the species should be provided.

**Table 4.1: Summary of Spatial Requirements Applying to Hooded Plover Exhibits in Victoria** (Department of Environment and Primary Industries 2001)

| Group | Minimum floor (Sq Metres) | No. of birds | Minimum height (meters) For fully enclosed aviaries | Pond size as % of total floor area | Increase area of floor and pond in sq meters for each additional bird |
|---|---|---|---|---|---|
| GROUP 1: 10-30 cm birds: includes plovers. | 20 | 4 | 2 | 25% | 2 |

There should be more than one aviary available suitable for Hooded Plovers if breeding is attempted and more than a breeding pair are maintained at the facility. This will enable non-breeding birds to be moved to prevent aggressive territorial reactions during breeding, which has been found to be necessary at Adelaide Zoo (AZA 2014, L. Ellis, pers. comm.).

**Table 4.2: Recommended Enclosure Sizes for Hooded Plover**

| Requirement | Minimum floor (Sq Metres) | Maximum No. of birds | Minimum height (meters) For fully enclosed aviaries | Pond size as % of total floor area | Increase area of floor and pond in sq meters for each additional bird |
|---|---|---|---|---|---|
| Holding – minimum | 20 | 4 | 2 | N/A | N/A |
| Holding - preferred | 45 | 4 | 2 | N/A | N/A |
| Exhibit – minimum | 20 | 4 | 2 | 25% | 2 |
| Exhibit – recommended | 50 | 4 | 3-4 | 25% | 4 |
| Breeding – minimum | 50 | 2 – breeding pair only | 2 | 25% | N/A |
| Breeding - recommended | 100 | 2 – breeding pair only | 3-4 | 25% | N/A |

## 4.4 Position of Enclosures

No particular requirements for positioning enclosures for Hooded Plover or similar species have been identified. It would be prudent to position the enclosure so that protection is offered from the prevailing direction that bad weather would come from. Positioning in the open, and without overhanging trees, will provide preferential air circulation and reduce the risk of issues such as fungal growths in the substrate from decomposing leaf litter.

## 4.5 Weather Protection

Hooded Plovers inhabit exposed ocean beaches and inland salt lakes where they can be exposed to relative weather extremes of the Australian temperate regions of hot dry summers and cool wet winters (Weston 2003). However natural shelter does exist as birds can utilise changes in beach topography, wheel ruts, beach washed debris, dune vegetation or retreat to the back dunes (Buick and Paton 1999, Weston 2003). They have also been observed to leave beaches, with circumstantial evidence that they move inland or to more sheltered locations following severe storms (Lane 1991). Natural forms of shelter (logs / vegetation) should be provided in the exhibit so that birds can escape from adverse weather conditions (AZA 2014). An open exhibit is satisfactory, but a solid wall at one end and a proportion of roof space that is enclosed will enable the birds to retreat in the most extremes of weather (Duncan and Hawkins eds. 2009). The enclosures used for Hooded Plovers at Adelaide Zoo have used similar arrangements successfully, with the back wall and approximately 25% of the rear of the roof enclosed (personal obs.). The Shore Plover program provides small, moveable wooden shelters that provide both shelter and enrichment for the birds for the birds (R. Collen pers. comm.)

## 4.6 Temperature Requirements

Hooded Plovers inhabit the temperate areas of south-eastern and south–western Australia and will be exposed to a wide range of temperatures from a few degrees centigrade below freezing occasionally in winter at some sites, and to temperatures into the low 40 degrees centigrade in the summer breeding season. The normal range of temperatures will be much narrower than this.

In outdoor exhibits in temperate Australian locations temperature is not likely to require control by keepers. However natural forms of shelter (logs / vegetation) should be provided in the exhibit so that there is a temperature gradient available for the birds to find places within the exhibit to find comfort (AZA 2014).

If temperatures are likely to fall to freezing (0 °C) then indoor winter holding facilities should be available. An artificial heat source such as a heat lamp may need to be provided in institutions with prolonged colder temperatures below 4.5–7 °C for parts of the year (AZA 2014). Water within the exhibit should not be allowed to freeze, and should be heated or replaced if it does (AZA 2014).

In hot weather, provided there is enough shade provided that the birds in the exhibit do not have to compete for a shaded area, no special measures should be required (AZA 2014).

## 4.7 Substrate

The most natural substrate for Hooded Plovers is beach sand (Schulz and Bamford 1987, Weston 2003, Maguire *et al.* 2014). The birds housed at Adelaide Zoo are currently housed on sand (personal obs). Problems with bumblefoot on compacted dry sand appear to have been alleviated by keeping the sand moderately wet and raking over daily. Sawdust has also been used successfully at Adelaide, which was a less natural substrate but helped reduce the incidence of bumblefoot (L. Ellis pers. comm.), although elsewhere pine shavings as a substrate are reported to exacerbate problems (AZA 2014). Torquay's Living Coasts zoo are currently trailing fine 'play sand' to determine if this reduces the incidence of bumblefoot (L. Rowell 2014 pers. comm.). Hard surfaces such as concrete or gravel must not be used as they will lead to foot damage and bumblefoot (AZA 2014, Collen 2014). Mud is not advised because of the difficulty in cleaning, and the consequence of increased bacterial growth and infection (AZA 2014).

## 4.8 Nesting / Bedding Material

Hooded Plovers need no special nesting material, they lay in depressions in the sand substrate. In the wild they have been observed to nest preferentially next to items of beach washed debris and wrack, which reduce the likelihood of nest predation (Maguire *et al.* 2014 per Mead in prep, Cribbin 2012), and similar items available in the enclosure will be beneficial to promoting breeding. At Adelaide the captive birds were observed to form the nest scrape against fixed items in the exhibit (against rocks, the side walls, rear shelter area, against tree trunks, and near a rodent bait station) (L. Ellis 2014 pers. comm.).

## 4.9 Enclosure Furnishings

Enclosure furnishings that replicate the natural habitat of the Hooded Plover are likely to provide behavioural enrichment for captive Hooded Plovers. Whilst it would appear the beach habitat of the birds is bare, in reality there are a number of habitat levels that Hooded Plovers use and within this range topographic variation, beach washed debris and (to a lesser extent) vegetation are important habitat features Weston 2003, Maguire *et al.* 2014). For the captive held birds at Adelaide Zoo rocks, logs and vegetation in the exhibit are used for shelter and are favoured locations for forming nest scrapes compared to the bare substrate (L Ellis 2014 pers. comm.). Furnishings can also reduce territoriality by enabling the birds to hide from an aggressor (AZA 2014). Positioning of furnishings should not become an 'assault course' for the birds though, that would prevent them from running and foraging around the enclosure naturally and exercising properly, or lead to stress if they perceive they cannot effectively get away from aggressive birds in the exhibit or when staff enter the enclosure.

### 4.9.1 Vegetation

Hooded Plover have no particular vegetation associations. Studies in the wild have found them near non-native weed species more often than native species of vegetation, though this was thought to reflect the prevalence of non native vegetation in coast areas rather than a preference (Cousens et al. 2013).

**Table 4.2: Predominant species of plant recorded closest to Hooded Plover nests** (Cousens *et al.* 2013)

| Common name | Scientific name |
|---|---|
| Hairy Spinifex | *Spinifex sericeus* |
| Marram Grass | *Ammophila arenaria* |
| Sea-wheat Grass | *Thinopyrum junceiforme* |
| Sea Spurge | *Euphorbia paralias* |
| Sea Rocket | *Cakile maritime* |

A small variety of grasses and small shrubs / trees should be available within the exhibit. This will enable the birds to find shelter from adverse temperature or weather conditions and perceived threats (Holland and Schroeder undated). The exhibits at Adelaide Zoo have a variety of grasses, and small trees / shrubs within them. The Hooded Plovers have been observed using these for shelter from perceived threats and have nested against a tree trunk at times (L. Ellis 2014 pers. comm.).
Some types of plant might cause problems for care of the birds and should be avoided. Species that drop sharp needles or abrasive leaves might exacerbate foot care problems (L. Rowell 2014 pers. comm.), while species that drop fruits or create excessive leaf litter increase the risk of aspergillosis (L. Ellis 2014 pers. comm.). Tall dense vegetation should be avoided as this may cause birds to become stressed or panicked (Holland and Schroeder undated).

### 4.9.2 Water

Water must be provided within the exhibit, covering a minimum of 25% of the exhibit area (Department of Environment and Primary Industries 2001), with 33-50% recommended elsewhere for the similar Shore Plover (Collen 2014). The edges should be gradually sloping and not a substrate that will become slippery, or so hard that the birds will damage their feet (AZA 2014). Sand would be preferred. The depth should be no more than 1/3$^{rd}$ the height of a Hooded Plover (AZA 2014). Brackish water is preferred as it will assist with reducing the risk of bumblefoot, but freshwater is acceptable, and is used at Adelaide. If freshwater is used then food should be presented inside a saltwater bath so that the bird's feet are still exposed to saltwater regularly. To reduce the incidence of territorial aggression the provision of multiple small pools is preferred (AZA 2014).
Running water provides benefits in that it has been observed to encourage more natural foraging and bathing behaviour, and helps keep the water clean. It should move slowly enough that the birds are not swept along (AZA 2014). Some facilities have found wave machines encourage plovers and sandpipers to run along the tide line as they would in the wild (AZA 2014, L. Rowell 2014 pers. comm.).

### 4.9.3 Other items

A selection of typical beach features is important for providing hiding places, shade and weather protection and potential nesting sites for plovers in captivity (AZA 2014). For the Hooded Plover driftwood, plastic boxes, rocks and formations in the substrate (artificial 'tyre ruts' or small sand piles of 'dunes') would all provide appropriate enrichment to the captive birds (pers. obs).

# 5 General Husbandry

## 5.1 Hygiene and Cleaning

Regular inspection and cleaning of the enclosure is necessary to ensure that the risk of infection or injury is reduced to the minimum (AZA 2014). Humans accessing the enclosure will cause the birds stress so care should be taken to ensure that birds do not feel trapped or 'boxed –in' by the keepers cleaning activities. This is especially true when the birds are breeding. A balance between maintaining a good standard of cleanliness and reducing stress to the birds needs to be achieved (AZA 2014).

**Table 5.1: Recommended inspection and cleaning regime**

| Activity | Frequency | Reference |
|---|---|---|
| Remove visible faecal matter from substrate and exhibit furniture | Daily | AZA 2014, Collen 2014 |
| Rake over / 'fluff up' substrate | Daily | Adelaide Zoo, AZA 2014 |
| Spot clean under feed trays for other bird species held in exhibit | Daily | Adelaide Zoo |
| Visual check for any mould / fungi: remove and flush with saline solution / disinfectant if found | Daily | AZA 2014 |
| Remove any dead plant matter | Daily | Collen 2014 |
| Drain / refresh water in still pools | Every other day | Adelaide Zoo |
| Wash salt water tray and replace salt water (at feeding station) | Every 2-3 days | R. Collen pers. comm. |
| Generally hose down the exhibit, dampen the sand | Every 3 days | Adelaide Zoo |
| Coliform test of water | Every 3 days | AZA 2014 |
| Renew vermin trap baits | Weekly | Collen 2014 |
| Move feeding tray to a new location in enclosure | Monthly | R. Collen pers. comm. |
| Clean and disinfect salt water trays (at feeding station) | Monthly | Collen 2014 |
| Fungal spore test of air | 6-monthly | AZA 2014 |
| Faecal test | 6-monthly | Adelaide Zoo |
| Renew substrate | 6-monthly | Adelaide Zoo |
| Visually check the enclosure structure for cleanliness of walls, damage, gaps, drains functioning properly etc. | 6-monthly and after storms | Collen 2014 |

For disinfecting equipment, trays etc. a specialised broad spectrum disinfectant, suitable for use with animals, should be used such as Anistel or Virkon®S. Anistel has two recommended dilution levels, 1:200 for general cleaning, and 1:100 for some specific high risk organisms or more soiled conditions (http://www.tristel.com/products/animal-health/surface-disinfection/anistel-high-level-surface-disinfectant/). A 1:100 dilution is typical for Virkon®S, but the suppliers guidance should be followed for specific target organisms, as stronger applications are required (http://www.lienerts.com.au/content/media/PDF%20Fact%20Sheets/Biosecurity%20Products/NEW%20Virkon%20S.pdf).

To minimise risk to the birds disinfection should be undertaken outside of the aviary, and equipment thoroughly rinsed with fresh water before being returned to the aviary (R. Collen pers. comm.)

## 5.2 Record Keeping

Good record keeping is necessary to track the health of individuals and the population as a whole, and enable staff to track issues, intervene in problems or make improvements to captive management (AZA 2014). Records should be updated frequently, ideally on a computerised system. Adelaide Zoo uses the ZIMS system but there are others (e.g. ARKS).

The following records should be maintained for each bird kept:

- Hatch date, parents (if known) and type of birth (wild born or captive born)
- If eggs collected from wild, location / population collected from
- Rearing method: parent raised or artificially raised
- Sex: male / female / unknown
- Identification: ID band number, leg flag or colour ring details
- Any health problems and treatment, disease screening and pathology results
- Changes in diet
- Weight monitoring
- Behavioural notes: any signs of stress (stereotypic pacing etc.), agonistic behaviour between conspecifics or other species held with the bird
- Breeding attempts: nest scrape formation, eggs laid, fate of eggs or chicks parented
- Issues identified in enclosure even if no problem with birds at that time: e.g. high fungal spore counts, high e.coli in ponds, issues in faecal tests
- Movements: between enclosures, to veterinary / quarantine / holding faciltites or other institutions
- Death details: date, cause if known

## 5.3 Methods of Identification

Birds should be fitted with a metal number band on the right tarsus. The band should be made from incoloy, and be 4mm diameter, 5.5mm high, 0.35mm gauge band following the Australian Bird and Bat Banding Scheme requirements (ABBBS 2000) Darvic PVC coloured bands or coloured leg flags have been used to monitor Hooded Plovers in the wild as individuals are easier to identify at a distance. Coloured Darvic PVC bands are used at Adelaide Zoo (personal obs.)

## 5.4 Routine Data Collection

There is limited data from the captive breeding at Adelaide Zoo on egg mass changes during incubation, and growth of chicks post hatching. Data on daily changes in egg weight / dimensions, and chick weight / development should be collected during any future captive breeding so that better data can be shared between institutions on expected developmental rates to assist in the monitoring of breeding and improve success rates.

# 6 Feeding Requirements

Wild Hooded Plovers are microfaunivores, with a broad diet consisting of a variety of invertebrates that they forage the beach for opportunistically. They have also been observed to eat vegetable matter (Shultz *et al.* 1984, Weston 2007).
No detailed analysis of the nutrient balance of the Hooded Plovers natural diet has been made, like has been completed for its congener the Shore Plover. Future research in this area would enable a captive diet to be formulated that would better replicate the physiological needs of the birds (Cottam 2000, McWilliams 2008, AZA 2014).

## *6.1 Captive Diet*

The following diet is given daily each morning to the Hooded Plovers at Adelaide Zoo, and is sufficient for two birds (L. Ellis 2014 pers. comm.):

- 60g finely minced meat
- 6x eggs including shell
- 60g petfood biscuits
- Wombaroo insectivore mix

Food consumption should be monitored daily. There should be a small amount of food left in the feed bowl at the end of each day, if not the amount should be increased slightly until it meets the demands of the birds (AZA 2014, Collen 2014). Diet may have to be increased significantly, up to double, during breeding and chick rearing (AZA 2014). The birds also have access to a shallow brackish or freshwater pool for natural foraging of aquatic invertebrates (personal obs.) If a brackish pool is provided then a separate dish of freshwater should be provided for drinking.

## *6.2 Supplements*

Supplemental calcium has been found to be needed by the Hooded Plover female during breeding to prevent thinning of eggshells, which has been found to be a problem (L. Ellis 2014 pers. comm.). It is recommended to start the birds on supplemental calcium one month before breeding starts (AZA 2014). Vitamin E during the breeding season may also improve fertility and egg viability (AZA 2014).

## *6.3 Presentation of Food*

The Hooded Plover food is presented to the birds each morning in a flat-bottomed ceramic bowl (approx 8.5 cm diameter x 4.5 cm deep). The food bowl must be placed in the centre of a shallow serving tray of salt-water solution (35g salt to 1L of water (Holland and Schroeder undated)), to assist in bumblefoot management (L. Ellis 2014 pers. comm.). If several birds are held together then more than one food bowl should be provided to minimise territorial aggression (AZA 2014).

**Figure 6.1: Food presentation for Hooded Plover at Adelaide in salt-water tray bath** (Photo: M Honeyman)

Ideally the tray in Figure 6.1 would be levelled so that salt water is evenly distributed around the food bowl, and filled to the brim (~2cm).

### 6.4 Natural Food

While the Hooded Plovers are able to forage for invertebrates in the substrate, shallow pools and logs within the enclosures at Adelaide they are not proactively provided with live food (personal obs). Presentation of live food in some way close to the natural foraging environment will help enrich the environment for the captive birds, and may be useful in building skills in captive born birds for release to the wild. The Shore Plover program has collected fresh seaweed from beaches near to facilities in the past to provide them with sand hoppers and other invertebrates naturally found on the coast (Collen 2014). Hooded Plovers forage in the wrack line and between the low tide mark and mid-tide levels (Shultz *et al.* 1984, Weston 2003). Provision of live food such as mealworms or sand hoppers scattered at the edge of exhibit water to encourage natural foraging, or a variable water level and foraging for invertebrates that might naturally occur are likely to be beneficial (pers. obs.)

## 7 Handling and Transport

### 7.1 Timing of Capture and Handling

There is no specific requirement for the timing of capture of Hooded Plovers, but ideally the birds would be caught up early in the morning before they become too active and before the public enter the zoo.

### 7.2 Catching Bags

The bird can be held in a small 25cm x 20cm calico bag, available from bird banding supply companies (Weston and Elgar 2005).

## *7.3 Capture and Restraint Techniques*

### 7.3.1 Hand netting

In the relatively small enclosures at Adelaide Zoo the birds are usually caught using a hand net. Two keepers enter the enclosure to expedite the operation as quickly as possible to minimise stress to the bird and others in the enclosure (L. Ellis 2014 pers. comm.). A 550mm diameter hand-net with a12mm mesh soft synthetic cone netting can be used (Dennis and Ball 2013).

### 7.3.2 Nocturnal capture method

This technique has been used in the wild effectively is to catch Hooded Plovers at night, as they have been found to become transfixed by the light and readily approachable. A 50watt hand held halogen hunting spotlight is trained directly on one bird as it is approached with a hand net. A 80mm deep tube shroud around the light reduces the light reflecting back off the operator. The bird should be slowly approached and then caught with the hand net in one swift movement once close enough (Dennis and Ball 2013)

### 7.3.3 Noose Mats

Wild Hooded Plovers have successfully been caught using a 'noose mat', following a design developed for other similarly sized plover species (Weston *et al.* 2004,). This technique is used for captive Shore Plover (Collen 2014) and would be suitable for catching captive Hooded Plovers, particularly in larger enclosures. Noose mats consist of a series of running nooses made of fishing line attached to a strip of plastic mesh, approximately 900 x 100 mm in size. When birds walk across the mat, their feet are caught in the nooses.
Noose mats work well with plovers, as they often prefer to run rather than fly away from an approaching keeper, and can be herded across the mat (Collen 2014).

Tips for safe and successful noose mat use (Collen 2014):

- All the nooses must stand upright and in the same direction. They should sit parallel with the length of the mat, and there should be no gaps between adjacent nooses that birds could walk through
- Any nooses that are twisted or will not sit right should be replaced before the mat is deployed.
- Arrange the noose mat where there birds are likely to run or easiest to herd, or create a likely pathway by rearranging exhibit furniture if necessary.
- The noose mat must be securely attached to the ground so that birds cannot fly away with it attached.
- The noose mat must be completely flat on the substrate. If possible, disguise with a light covering of sand so the plastic is less visible.
- One person should do the 'herding'. Multiple people involved increases stress in the birds.
- Once a bird is caught, quickly and carefully approach the noose mat to free it.

Birds may become wary of a noose mat after being caught in one a few times, or witnessing other birds being captured. If it becomes difficult to catch particular individuals with a noose mat they can be lured with food or playing alarm calls.

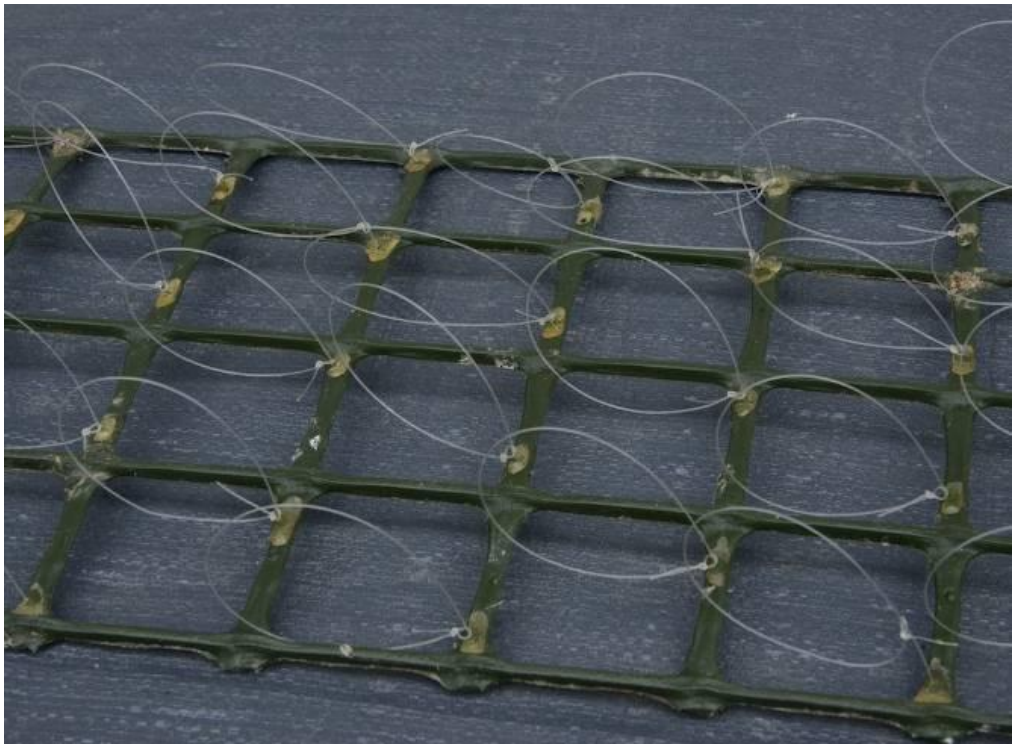

**Figure 7.1: Noose mat used to capture Shore Plover: similar to those used for Hooded Plover.** (Photo: J Dowding)

### 7.3.4 Handling

Once caught the bird is extracted from the net and restrained using a conventional ‘bander’s grip’ for small birds (palm over the bird’s back, fingers around the body and the head between the index and middle fingers) (L. Ellis 2014 pers. comm.). Handling should be kept to a minimum. There are anecdotal reports of birds succumbing to stress when captured (Peter Dann 2014 pers comm).

**Figure 7.2: Demonstration of the 'Bander's Grip' standard hold for small birds** (Photo: M Honeyman)

**Figure 7.3: Standard hold for small birds** (from Collen 2014 per Mander et al.. 2003)

## 7.4 Weighing and Examination

A quick physical examination should include inspection of the birds legs, feet, bill, eyes, vent and feather condition (AZA 2014). Birds should be weighed in the bag using a 500g spring balance scale, accurate to 0.5g (Weston and Elgar 2005).

## 7.5 Release

Birds should be released away from the walls of the enclosure so that they do not fly up and injure themselves, and ideally near some shelter or cover that they can use to compose themselves (AZA 2014).

## 7.6 Transportation Requirements

For short movements within the facility or to a veterinary facility commercial pet boxes or a sturdy well ventilated cardboard box (or commercially available 'penguin box') has been used to transport Hooded Plover (L. Ellis 2014 pers. comm., Weston 2014 pers. comm.). There is no data for longer distance /duration transfers of Hooded Plover. The IATA require that shorebirds should be transported in a box enabling them to stand fully erect without touching the sides or top of the container (AZA 2014). A sturdier transfer box design has been developed for the Shore Plover that should be suitable and is described below (Collen 2014).

## 7.7 Box Design

Short transfers in a small plastic commercial pet carrier box (typical dimensions 530mm x 410mm x 380mm) are acceptable. Vents should be covered with a 1-2mm gauge shade cloth to prevent birds poking their bill through, reduce their exposure to outside activity and prevent the entry of insects (AZA 2014).

Shore plover transfer boxes are made from 10 mm plywood and have the following features (Collen 2014). As Hooded Plover are relatively large compared to Shore Plover, dimensions have been increased accordingly by ~30% (author):

**Table 7.1: Recommended Transfer Box Sizing based on Shore Plover boxes** (Adapted from Collen 2014)

| Feature | Details |
|---|---|
| Dimensions: single bird transfer box | 400mm long x 350mm wide x 280mm high |
| Dimensions: multiple birds transfer box | 800mm long x 350mm wide x 560mm high (four compartments) |
| Ventilation | 150mm square ventilation grate to each compartment with shade cloth to reduce the exposure to outside activity and prevent birds getting bill trapped (AZA 2014) |
| Padding | Closed cell foam lining over walls |
| Floor | Brooder matting or similar suitable non-slip liner |
| Door | 180mm x 200mm vertical sliding door. Hinged doors are more likely to catch the bird when attempting to close, it is easier with a sliding door to restrain the bird until the very last moment then withdraw fingers |
| Handle | A carrying handle is added to the top of the box for convenience |

**Figure 7.4: Closed-cell foam lining and brooder matting inside a transfer box.** (Photo: Darren Page)

**Figure 7.5: Four-bird transfer box.** (Collen 2014)

When birds are air freighted, transfer boxes must have labels on them indicating 'Live birds', and 'This Way Up' (AZA 2014).
Transfer boxes must be cleaned and disinfected before and after use.

### 7.7.1 Furnishings

The box should include a rubber matting (not newspaper as this may become slippery with faeces) to help the bird keep a secure footing (AZA 2014).

### 7.7.2 Water and Food

Birds should be given water and food before they are transferred. For short trips of no more than a few hours no special water or food arrangements need to be made. For longer trips arrangements should be made to have intermediate stops as required with a quite secure room where the birds can receive food and water (R Collen pers. comm.)

### 7.7.3 Birds Per Box

One bird should be transported per box / compartment within the box (AZA 2014).

### 7.7.4 Timing of Transportation

No specific requirements have been identified, however it would be prudent not to transport the birds in the afternoon on particularly hot days. Transports by car have required use of the vehicles air conditioning on hot days to prevent Hooded Plover becoming overheated during transfer (Weston 2014 pers. comm.). Longer road transfers (greater than a couple of hours) are best carried out overnight, when the birds would normally be at rest anyway (Collen 2014).

### 7.7.5 Release from Box

It is important to ensure that the bird has not been injured during transport so before release it should be caught and visually inspected for any injury, particularly to limbs, wings (AZA 2014)

# 8 Health Requirements

## 8.1 Daily Health Check

Birds should be visually checked each day to observe any indicators of ill health. Useful visual indicators of ill health in birds are (Kilduff *et al.* 2011):

- Breathing issues (open beak or gaping)
- Fluffed up appearance
- Lethargy
- Poor appetite
- Abnormal consistency or volume of faeces
- Limp tail or wings
- Hiding in exhibit, noticeably less confident or social than normal
- Eyes shut, enflamed or weeping
- Limping or difficulty walking

## 8.2 Detailed Physical Examination

A thorough physical examination should take place at least once a year (AZA 2014, L.Rowell 2014 pers.comm.), in the period while a bird is isolated in pre-transfer quarantine (AZA 2014, Collen 2014) and at other times opportunistically when there is a need to handle the bird anyway (AZA 2014). The physical examination should consist (AZA 2014):

- Check body weight
- Take blood sample and blood count and biochemical test suite
- Faecal sample and conduct faecal culture and parasite screen
- Check bands are correctly fitted

Additional physical examination recommendations from the Shore Plover program and Living Shores Zoo (Collen 2014, L.Rowell 2014 pers. comm.):

- Examine each bird in the hand for bumblefoot or pox lesions on feet and legs, and external parasites.

## 8.3 Routine Treatments

Screening for faecal parasites should be undertaken every six months and the birds treated for parasites as required. No other routine treatments are recommended (AZA 2014).

**Table 8.1: Drugs commonly used on Charadriiformes** (AZA 2014)

| Drug requirement | Commonly used drugs for charadriiformes | |
|---|---|---|
| Anaesthetic gas | Isoflurane | Sevoflurane |
| Antibiotics | Amoxicillin<br>Cephalexin<br>Clindamycin<br>Enrofloxacin | Metronidazole<br>Triethoprim-sulfamethoxazole |
| Antifungals | Amphotericin B<br>Fluconazole | Intraconazole<br>Nystatin |
| Parasitides | Fenbendazole<br>Ivermectin | |

## 8.4 *Known Health Problems*

Health problems identified during the nearly 21 years of captive management of the Hooded Plover at Adelaide Zoo are described below

### 8.4.1 Aspergillosis

#### 8.4.1.1 Cause

Aspergillosis is an infection caused by the fungus *Aspergillus fumigates*. It is relatively rare in wild shorebirds but common in captive birds (AZA 2014). There were 2 cases of Aspergillosis in juvenile captive Hooded Plovers at Adelaide Zoo in 1995, and both led to rapid mortality (L. Ellis 2014 pers. comm.). The Aspergillus species of fungus can grow in exhibit substrate, especially decaying organic matter, and has been observed at Adelaide to be more prevalent in aviaries below trees, especially fig trees (L. Ellis 2014 pers. comm.), it can also occur when the air changeover is inadequate or when there is excessive humidity in the exhibit (AZA 2014). Transmission is via inhalation of spores, which then develop in the bird's respiratory system. Aspergillosis is not considered to be an infectious disease (AZA 2014).

#### 8.4.1.2 Signs

Aspergillosis most often affects individuals that are already ill, breeding, subject to competition or aggression or otherwise stressed, however a high environmental spore load may lead to the infection of healthy birds (AZA 2014, Collen 2014). Symptoms include dyspnea (laboured breathing), other signs of respiratory distress (panting or open mouthed breathing), voice changes and loss of appetite, loss of weight and general lethargy. Unfortunately once symptoms are apparent the bird is often too ill for effective treatment and the diagnosis is terminal (AZA 2014, Collen 2014).

#### 8.4.1.3 Diagnosis

Diagnosis of aspergillosis includes blood count, biochemistry suite, fungal culture, aspergillosis antigen and antibody levels, protein electrophoresis, radiography or endoscopy. Serological tests should not be used on Hooded Plover as they have not been validated in *Charadriiformes* (AZA 2014.)

#### 8.4.1.4 Treatment

Treatment requires intensive care in a veterinary clinic, with systemic antifungal drugs (intraconazole) and sometimes nebulisation with an antifungal agent such as terbinifine to reach the airways (AZA 2014).

#### 8.4.1.5 Prevention

Measures that can be taken to prevent aspergillosis include (AZA 2014, Collen 2014):

- Minimise social stress on the birds, monitor for aggression and separate birds if required
- Appropriate aviary design: good airflow, good access to daylight, not overhung by trees
- Appropriate aviary management: good standard of cleanliness, removal of dead organic material, daily turning over of substrate

### 8.4.2 Pododermatitis (Bumblefoot)

#### 8.4.2.1 Cause

Pododermatitis, commonly known as Bumblefoot, is an infection of the foot or tarsal joint. The principal cause is abrasion of feet by the exhibit substrate, that enables bacteria to enter and cause symptoms such as swelling on the foot or leg, limping, and lameness (AZA 2014).

#### 8.4.2.2 Signs

Birds present with limping, lameness, sores and swelling on the feet and tarsal joint (AZA 2014).

#### 8.4.2.3 Diagnosis

Bumblefoot can be difficult to tell from avian pox, but pox tends to be much more persistent and less responsive to treatment (AZA 2014, Collen 2014).

#### 8.4.2.4 Treatment

Treatment depends on the severity of the infection. Mildly affected birds may be isolated for treatment with a course of anti-inflammatory drugs and / or antibiotics, ideally administered in the food or directly if necessary. Advanced cases of bumblefoot may require padding / bandaging of the foot and in severe cases surgery to remove dead tissue (AZA 2014). Adelaide Zoo have tried bandages, padding / socks and plasters with some success but have found that prevention is most effective (L. Ellis 2014 pers. comm.).

#### 8.4.2.5 Prevention

Incidence of bumblefoot can be reduced by:

- Maintaining a damp sand substrate in the exhibit (L. Ellis 2014 pers. comm.)
- Providing salt water foot baths at feed stations (L. Ellis 2014 pers. comm., Collen 2014, Holland & Schroeder).
- Keeping the substrate in good condition, raked over daily (L. Ellis 2014 pers. comm., AZA 2014)

### 8.4.3 Avian pox virus

#### 8.4.3.1 Cause

Avian pox is a disease caused by an avipoxvirus. It is transmitted initially by biting insects, and can then be transmitted from bird to bird contact, directly or secondarily (i.e. if an infected bird contaminates a feed station) (Friend & Franson 1999). It has been recorded in three individuals in the captive Hooded Plover population. Two individuals recovered after veterinary care, and a third died. These instances appear to be the ‘cutaneous’ variant of avian pox, where large growths occur on the bird’s feet or legs. The diphtheritic or "wet" avian pox where growths form in the mouth, throat or respiratory system has not been reported in captive Hooded Plover (L. Ellis 2014 pers. comm) although one unspecified death in the ZIMS database appears to show potential symptoms (ID# A40191) (pers. obs.).

#### 8.4.3.2 Signs

Avian pox appears as one or more lesions or small red lumps on the foot or leg. The lesions increase in size and become raw and fleshy. Bacteria may gain access causing secondary infection and result in necrosis and pus discharge. The cutaneous form of pox is self-limiting, and as the lesions begin to heal it gradually separates from the healthy tissue and forms a dark dry scab. Eventually, the scab falls off revealing healed skin underneath (Friend & Franson 1999 Collen 2014).

#### 8.4.3.3 Diagnosis

A presumptive diagnosis of avian pox can be made from the gross appearance of the wart-like growths that appear on the skin. However, these observations can be confused with bumblefoot. A confirmed diagnosis can be obtained by taking swabs or biopsies of lesions, and examining microscopically or by molecular diagnostics (Collen 2014).

#### 8.4.3.4 Treatment

Commonly birds with foot and/or leg lesions do not limp or appear to suffer any reduced mobility as they would with bumblefoot. It is associated secondary bacterial and fungal infections that can cause mortality if left untreated. Birds with suspected pox lesions should be brought into an individual holding pen or the veterinary facility for treatment. The infected bird should be treated with a course of antibiotics.
The infected bird should remain in isolation until the lesions start to dry out and go dark. This may be as long as 1-2 weeks. For Shore Plover, the recovery time for complete healing of the affected skin is most commonly 6-8 weeks (Collen 2014).

#### 8.4.3.5 Prevention

The Shore Plover program has successfully developed and used special insect-proof aviaries for the captive breeding program, when biting insects are seasonally prevalent to reduce the risk of avian pox transmission. The insect proof aviary consists of a very fine (0.5mm mesh) polypropylene secondary wall / roof structure within a conventional enclosure that completely excludes biting insects (Collen 2014). However this would be unsuitable for use in a public exhibit as it would exclude viewing of the birds.

### 8.4.4 Parasites

Internal parasites (ascarids) and external mites have been found in Hooded Plover on occasion, or in group faecal samples taken in shared aviaries. They have not yet been known to cause illness or mortality (Loren Ellis 2014 pers. comm.).

#### 8.4.4.1 Cause

Contact with wild caught birds in the exhibit, or wild pests that have entered the exhibit, is the most likely cause of parasite transmission, and for this reason parasites appear to be a have had a low incidence in the Hooded Plover (pers. obs.).

#### 8.4.4.2 Diagnosis

Internal parasites: faecal or cloacal swabs for laboratory examination
External parasites: physical examination of the feathers to locate mites

#### 8.4.4.3 Treatment

Treatment with de-worming medicine (invermectin) and dusting with a pyrethrin-based parasiticidal has been effective in managing parasite issues with shorebirds (AZA 2014).

#### 8.4.4.4 Prevention

Good exhibit cleanliness practice is the best way to reduce the risk of parasites in the Hooded Plover exhibits.

### *8.5 Quarantine Requirements*

Institutions must have a suitable holding / quarantine facility where a sick or injured bird can be held for treatment, and general requirements for the quarantine room are covered under Section 4.2 'Holding area design' (AZA 2014). Quarantine period for birds being introduced to the institution should be not less than 30 days. Routine testing should follow 8.2.2 'Physical examination' (AZA 2014).

# 9 Behaviour

## *9.1 Activity*

Wild Hooded Plovers, when not breeding, spend just under half their time foraging along the beach between the tide line and the dunes, and one third of their time (~38%) loafing (sitting or standing). Preening is the other significant activity (~10% of time spent). In the breeding season incubation becomes the most significant activity, for both the male and female, but foraging, preening and loafing continue to take up the remainder of the birds time (Buick and Paton 1989)

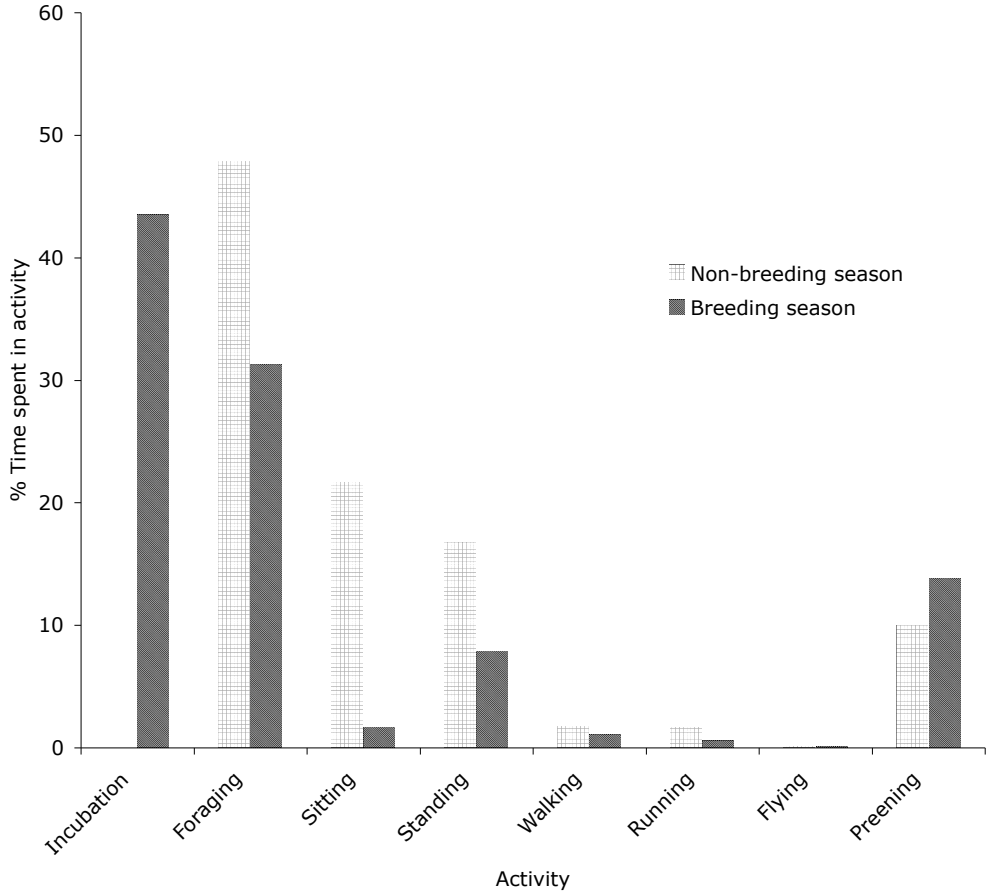


**Figure 9.1: Hooded Plover activity time budget in breeding and non-breeding period** (Buick & Paton 1989)

The majority of foraging takes place in the zone of wave wash / recession during low / mid-tide. During high tide the birds are most likely to loaf at the upper beach / fore dune (Schultz *et al.* 1984).

## *9.2 Social Behaviour*

Hooded Plovers form solitary pairs that share incubation and brooding of their offspring equally. They are aggressively territorial in the breeding season, but associate in flocks in the non-breeding season. In the eastern sub-species the flocks consists of as many as 30-50 mixed adult, sub-adult and juvenile birds. Flocks as large as 100 have been recorded exceptionally (Weston 1998, Schultz 1987, Cooper 1997). These flocks can be very large (several hundred birds) in the winter flocks of the western sub-species (Weston *et al.* 2004). Typical home territory size for a breeding pair is 1km of coastline. Non-breeding birds form small flocks and often come into conflict with resident breeding pairs (Weston *et al.* 2009).

## *9.3 Reproductive Behaviour*

Hooded Plovers have a ritual scrape forming display similar to other plover species. Breeding can start as early July and continue until as late as April, but August – March is the more normal range. Nest scrapes can be formed up to a month before eggs are laid (L. Ellis 2014 pers. comm., Baird and Dann 2003, Weston 2000).

## 9.4 Bathing

Bathing habits are not known, but plovers typically bathe in shallow water or ponds (pers. obs).

## 9.5 Behavioural Problems

Some stereotypic pacing and disorientation has been observed very rarely in the Hooded Plovers at Adelaide Zoo, but the adult birds have not been observed to show significant signs of stress in captivity, unless suffering from a health issues (L. Ellis 2014 pers. comm.). However whether the stress precipitated the illness or the illness precipitated the stress needs further investigation in the future (pers. obs.)

## 9.6 Signs of Stress

No signs of stress have been noted in captive Hooded Plovers (L. Ellis 2014 pers. comm.).

## 9.7 Behavioural Enrichment

Behavioural enrichment techniques should be employed to stimulate captive Hooded Plover and encourage natural behaviours such as foraging, preening and breeding activity. Encouraging the birds to wade into water more often may also reduce the incidence of bumblefoot (AZA 2014) Given the observed foraging patterns of Hooded Plover the provision of a water feature managed in a wave like / tidal motion might be important to encourage natural foraging behaviours (pers obs.).

The Association of Zoos and Aquariums has collated data on shorebird suitable behavioural enrichment techniques employed successfully at a number of institutions (AZA 2014):

**Table 9.1: Shorebird appropriate behavioural enrichment techniques** (AZA 2014)

| Enrichment technique | Description | Behaviour encouraged |
|---|---|---|
| Bird vocalisations | Play vocalisations of birds, avoiding aggressive territorial playback that might cause stress | Vocalisations<br>Search behaviour |
| Distributed feed | Distribute feed items around the exhibit either by scattering, using dispensers or hiding at the edge of exhibit furniture | More natural foraging behaviour |
| Live food | Offer live food such as annelids, insects | More natural foraging behaviour, running, walking |
| Vary food | Vary feeding times or food choices | More natural foraging behaviour |
| Vary water features | Create artificial tides or waves. Vary pond depths or locations | More natural foraging behaviour |
| Mirrors | Set up small mirrors in the exhibit (for short period of time only, and observe behaviour – remove if behaviour becomes excessively aggressive) | Vocalisations<br>Display behaviours |

| Enrichment technique | Description | Behaviour encouraged |
|---|---|---|
| Water mists / showers | Water mists or showers provided occasionally (particularly indoor aviaries) | Preening |
| Vary exhibit furniture | Introduce new items to exhibit, or move around existing items | Encourages exploration of exhibit |
| Modify substrate surface | Create small mounds in the exhibit (can be combined with food scattering) | More natural foraging behaviour<br>Encourages exploration of exhibit |

## *9.8 Introductions and Removals*

Introductions and removals / reintroductions should not be carried out in the breeding season if possible, as this is a time of maximum aggression in shorebirds (AZA 2014). Releases into an aviary should also be carried out on relatively 'quiet' times in the institution i.e. early in the week so the birds have the week to become accustomed to each other prior to being subjected to any additional environmental stressors (AZA 2014). Ideally they should also be carried out early in the day so that staff are available throughout the day to observe interactions for any issues (AZA 2014). Adelaide Zoo have employed intensive watches of Hooded Plover when birds have been returned from the veterinary facility (particularly when they were removed after being subject to aggression from conspecifics) (pers. comm. Ellis 2014.) For introductions from other institutions a 30-day quarantine period is required, during which the physical examination described in 8.2.2 Physical Examination should be carried out.

## *9.9 Intraspecific Compatibility*

### 9.9.1 Formed Breeding Pairs

Once a Hooded Plover pair is formed they tend to be monogamous and stable, and may remain together through many breeding seasons (Dennis and Masters 2006, Weston *et al.* 2009, Maguire 2014). Captive pairs formed at Adelaide Zoo have similarly remained stable across several breeding seasons (2-4 seasons– broken in each instance only by the death of one or more of the pair) without any behavioural issues or negative interactions being observed (L. Ellis 2014 pers. comm.)

### 9.9.2 Breeding Pairs and conspecifics

Breeding pairs will chase non-breeding Hooded Plover from their territory (Weston *et al.* 2009). Adults can become aggressive towards their fledged offspring particularly if a second clutch is being attempted, but at times can remain with their parents for several months (Maguire *et al.* 2014). In Shore Plovers the usual husbandry practice is to catch, band and move fledglings out of their natal flight at approximately 30 days of age, which is before the stage that aggressive behaviour is likely to occur (Collen 2014). At Adelaide Zoo there have occasionally been instances of aggression between the breeding pair and conspecifics and non-breeding plovers have had to be moved to alternate aviaries (L. Ellis 2014 pers. comm.).

### 9.9.3 Non breeding groups

In the wild non-breeding groups usually associate without excessive aggressive interactions, although some aggressive behaviours have been identified, possibly as a precursor to the flock splitting up to form breeding pairs again early in the season (Weston 1998b). At Adelaide Zoo there have been two instances of aggression recorded between non-breeding birds. One of these, when there were two non-breeding females together in the exhibit (and no male – a breeding pair was in another enclosure), was resolved when a third non-breeding female was introduced to the exhibit (L. Ellis 2014 pers. comm.).

**Figure 9.2: Hooded Plover non-breeding group** (Photo: Ross Jones)

## *9.10 Interspecific Compatibility*

Breeding Hooded Plovers in the wild will defend their nests aggressively against much larger birds, including other shorebirds, Silver Gull *Larus novaehollandiae*, Australian Magpie *Gymnorhina tibicen,* (Burke *et al.* 2004, Weston 2000, Weston 1998a). In captivity Hooded Plover have been housed with a variety of species (refer table). Aggressive interaction during the breeding season are frequent, and have resulted in the other species having to be moved to alternate exhibits on a number of occasions (L. Ellis 2014 pers. comm.). It is recommended that breeding pairs are kept in a dedicated enclosure without conspecifics or other species.

**Table 9.2: List of species housed with Hooded Plovers at Adelaide**

| Species that have been co-housed with Hooded Plover at Adelaide Zoo | |
|---|---|
| Black-winged Stilt | Orange Bellied Parrot |
| Eastern Whipbird | Honeyeater sp. |
| Superb Fairy-wren | Woodswallow sp. |

## 9.11 Suitability in Captivity

Notwithstanding many problems with bumblefoot, and issues with aggression between the plovers and other species co-housed with them at times, the Hooded Plover at Adelaide Zoo have proven easy to keep in captivity (C. Romer 2014 pers comm.).

# 10 Breeding

## 10.1 Mating System

Hooded Plovers are monogamous and typically form long lasting stable breeding partnerships (Maguire *et al.* 2014, Weston 2003).

## 10.2 Ease of Breeding

The only captive breeding population has been at Adelaide Zoo, so information on the ease of breeding is limited. While there have been some successful captive breeding attempts there have been issues with infertility and soft shelled eggs (L. Ellis 2014 pers. comm.) The cues for breeding are not understood at this time (Maguire *et al.* 2014), but inter-annual variations between commencement of breeding have been observed (Weston 2003).

**Pair 1 ID#930561 female & ID#930563 male**

This pair bred at 10 months of age (Dennis and Ball 2013, L. Ellis 2014 pers. comm.), laying two clutches in August 1994 and a single clutch in July 1995. All the clutches were removed for artificial incubation, which proved unsuccessful. No further breeding attempts were recorded, and both birds died in 1997 (L. Ellis 2014 pers. comm.).

**Pair 2 ID# 950482 female & ID# A10111**

This pair successfully bred several times at Adelaide Zoo. The first breeding attempts were in 2001, when the female was six years old, and the male 10 months old (Dennis and Ball 2013, L. Ellis 2014 pers. comm.). This was the first breeding season that 950482 had been housed with an unpaired male Hooded Plover. Table 10.1 summarises the breeding success for this pair.

**Table 10.1: Breeding Success of a breeding pair of Hooded Plover at Adelaide Zoo 2002-2005** (L. Ellis 2014 pers. comm.)

| Date | Clutch number | Success / fail and reasons recorded |
|---|---|---|
| March/April 2002 | 1 2001/2 season | 1 soft shelled egg lost<br>1 egg taken for incubation, replaced with dummy egg, unsuccessful |
| August 2002 | 1 2002/3 season | 2 eggs taken for incubation as birds disinterested, replaced with dummy egg, unsuccessful, infertile<br>1 soft shelled egg lost<br>1 v.small egg disguarded by keepers |
| September 2002 | 2 2002/3 season | 2 eggs<br>1 chick, parent raised (ID# A20656) |
| December 2002 | 3 2002/3 season | 1 egg laid infertile |
| January 2002 | 4 2002/3 season | 1 egg laid soft shelled<br>1 egg laid infertile |

| Date | Clutch number | Success / fail and reasons recorded |
|---|---|---|
| July 2003 | 1 2003/4 season | 1 soft shelled egg<br>1 egg taken for incubation, unsuccessful |
| July 2003 | 2 2003/4 season | 3 eggs laid. 1 infertile, 1 possibly hatched / predated post hatch by mice?, 1 lost, predated? |
| September 2003 | 3 2003/4 season | 3 eggs laid<br>2 chicks, 1 successfully parent raised (ID# A30540), 1 died soon after birth (ID# A30541)<br>1 infertile |
| November 2003 | 4 2003/4 season | 2 eggs laid<br>1 infertile, 1 pipped but died before hatched |
| December 2003 | 5 2003/4 season | 2 eggs laid<br>1 infertile, 1 stillborn |
| February 2004 | 6 2003/4 season | 2 eggs laid<br>1 chick successfully parent raised (ID# A40191) |
| May / June 2004 | Note | Three nests formed but no eggs laid |
| September 2004 | 1 2004/5 season | Three eggs laid artificially incubated, unsuccessful, no cause listed |
| October 2004 | 2 2004/5 season | Three eggs laid<br>1 chick successfully parent raised (ID# A40665)<br>2 remaining eggs infertile |
| February 2005 | 3 2004/5 season | 1 soft shelled egg |
| July 2005 | 1 2005/6 season | 1 soft shelled egg |
| August 2005 | 2 2005/6 season | 2 soft shelled eggs |

**Pair 3 UID female (of # A10110, # A20656 and # A30540) & ID# A40191 male**
The last breeding attempts at Adelaide were in the 2007-2010, but no chicks were hatched. The last male in the captive population died in 2010.

## *10.3 Reproductive Condition*

### 10.3.1 Females

There is no data on physiological clues to breeding condition.

### 10.3.2 Males

There is no data on physiological clues to breeding condition.

## *10.4 Techniques Used to Control Breeding*

Dummy eggs may be used to control breeding once the real eggs have been removed. If this is not done female Hooded Plovers would typically attempt to lay a replacement clutch. If the female lays repeated clutches of eggs then calcium levels may become depleted, affecting the fitness of the female and the viability of the eggs (AZA 2104). The dummy eggs should only be left in situ for the duration of the typical incubation period, otherwise the parents may suffer from physical problems associated with extended periods of sitting (AZA 2014).

## 10.5 Occurrence of Hybrids

There are no reported cases of hybridisation in the Hooded Plover documented. Hybridisation is uncommon in Charadriiformes (AZA 2014).

## 10.6 Timing of Breeding

In the wild Hooded Plovers have an extended breeding season from July – April, although August – March is more typical (Baird and Dann 2003, Weston 2000). The captive bred birds at Adelaide Zoo have followed a similar pattern (L. Ellis 2014 pers. comm.)

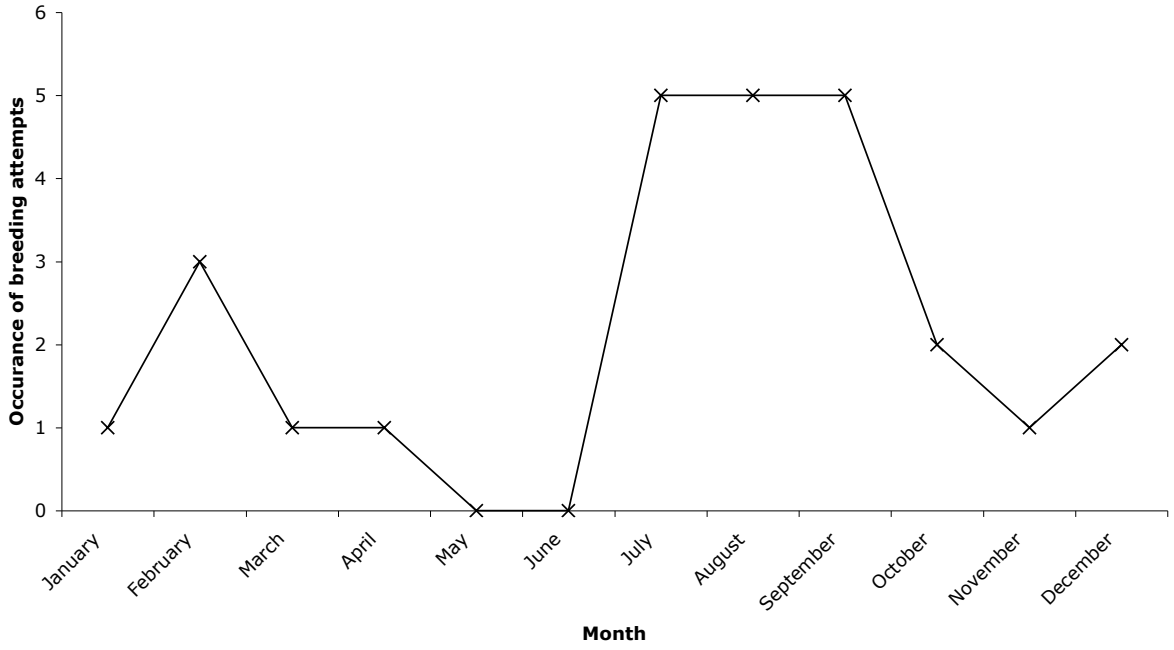


**Figure 10.1: Time of Year of Captive Hooded Plover breeding attempts – all records** (Data from Adelaide Zoo L. Ellis 2014 pers. comm.)

## 10.7 Age of First Breeding and Last Breeding

The age of first breeding in the wild and in captivity is 10 months (Dennis and Ball 2013). There is no published data on the age of last breeding in the wild, but one of the Adelaide breeding females was nine years old at her last successful breeding attempt and still breeding at ten years old when she died. (L. Ellis 2014 pers. comm.).

## 10.8 Frequency of Breeding

Hooded Plover can breed every year in common with most small bird species. Hooded Plovers in the wild have been observed to attempt additional clutches quickly after loss of a clutch, or successful fledging, and can breed up to seven times in a breeding season, although the average is just 1.8 (Maguire *et al.* 2014). At Adelaide Zoo a maximum of six breeding attempts has been recorded in a breeding season (L. Ellis 2014 pers. comm.).

## 10.9 Nesting Requirements

The birds nest in a small scrape in the substrate, often adjacent to a dead object / item or exhibit furniture, and there are no particular nest or space requirements (Maguire *et al.* 2014, Weston 2003).

## 10.10 Breeding Diet

Adelaide Zoo observed that the diet is increased for breeding birds (L. Ellis 2014 pers. comm.). For Charadriiformes it is advised that increased food be provided ad libitum to birds during breeding if specific food requirements are not known (McWilliams 2008)

## 10.11 Incubation Period

Hooded Plover have a protracted laying period, with one egg laid approximately every 48 hours, with incubation not commencing until the full clutch is laid (Maguire *et al.* 2014). The incubation period is 26-28 days. Hooded Plover have been known to incubate infertile eggs for up to 59 days (Weston 2003)

## 10.12 Clutch Size

Wild birds usually have 2-3 eggs and exceptionally up to 4 (Baird and Dann 2003, Weston *et al.* 1998).

## 10.13 Age at Fledging

Birds fledge at 35 days of age, range 34-39 days (Maguire *et al.* 2014, Weston 2003).

## 10.14 Age of Removal from Parents

Parent raised Hooded Plover need to be brooded for first two weeks as they are unable to independently thermoregulate (Weston 2003).

## 10.15 Growth and Development

Published data for the growth and development of wild born Hooded Plover chicks is presented in Figure 10.2.

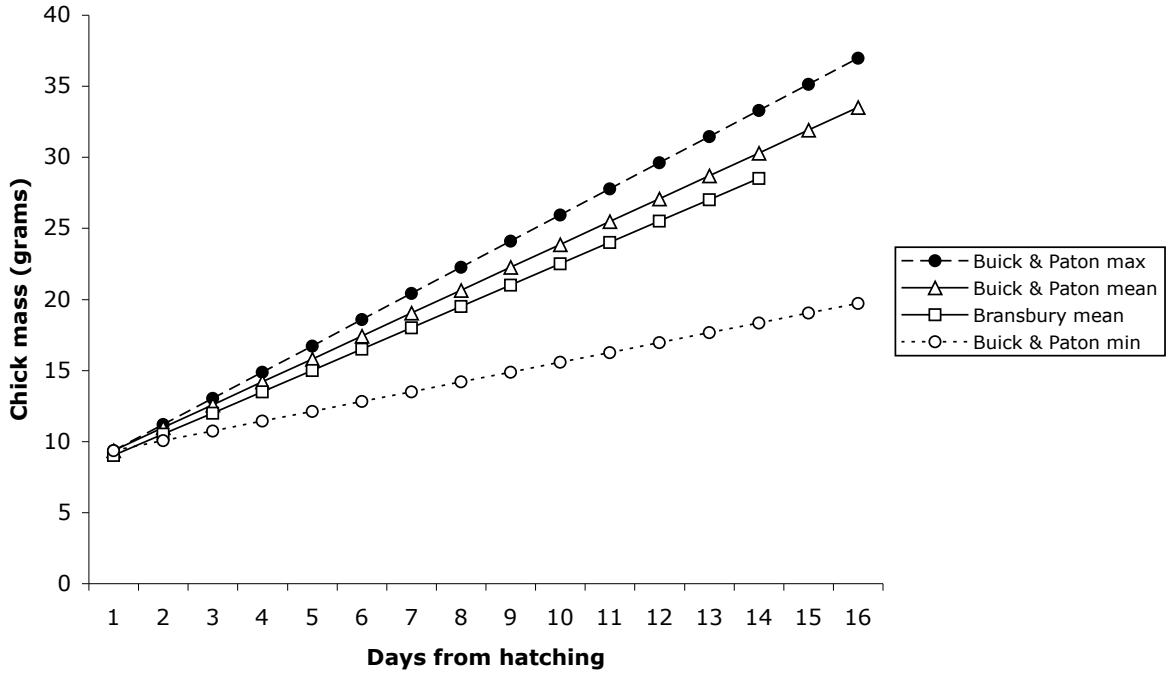


**Figure 10.2: Wild born Hooded Plover chick growth rate curves** (Bransbury 1991, Buick and Paton 1989)

Data from Adelaide Zoo for the growth and development of captive born and raised Hooded Plover chicks (and a single wild caught, captive raised individual Chick4) is presented in Figure 10.3.

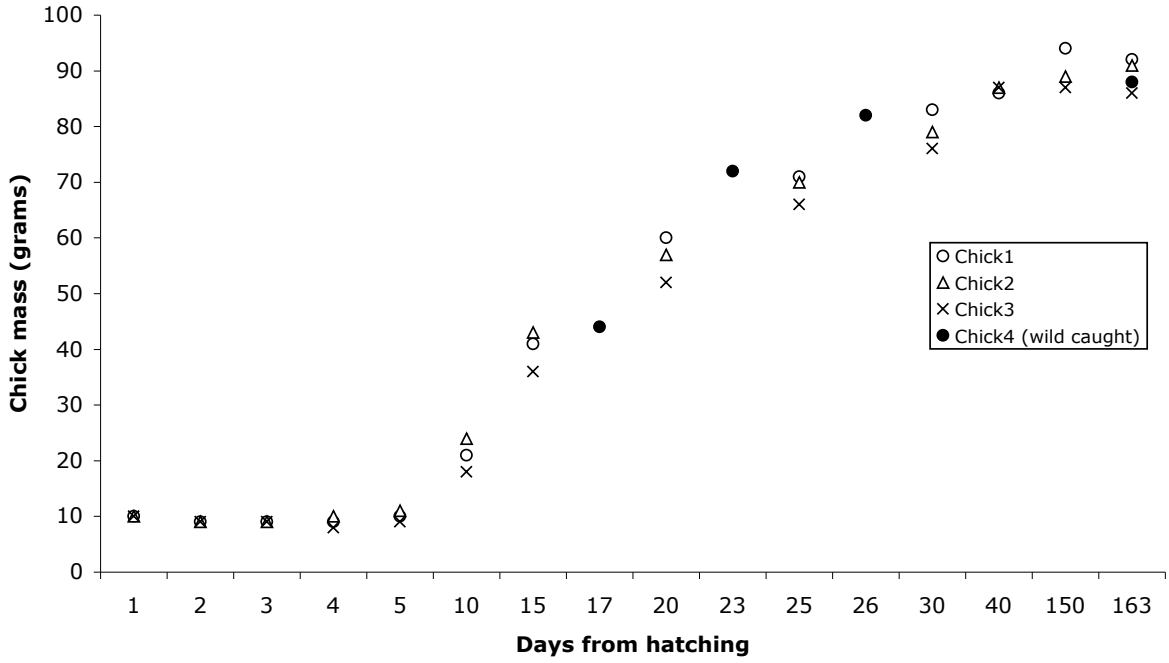


**Figure 10.3: Captive raised Hooded Plover chick growth rate curves** (Craig 1994 Unpub. data)

# 11 Artificial Incubation and Rearing of Birds

There is limited data on Hooded Plover artificial incubation and rearing, so the available data has been supplemented with information for the cogener to the Hooded Plover, the Shore Plover where necessary. At Adelaide Zoo clutches have been removed for incubation in several seasons, leading to multiple clutches being produced by the breeding birds.

## *11.1 Incubator Type*

An incubator with a proven record of temperature stability and a gentle turning mechanism should be used. Each clutch of eggs must be placed in a separate row in the incubator (or marked with pencil) so they can be clearly identified. All incubators should be monitored at least three times per day, data recorded and incubators adjusted if necessary, to ensure temperature and humidity remains stable (Collen 2014). Adelaide Zoo incubated Hooded Plover eggs in an A B Incubators Newlife75 automated incubator (Craig 1994 Unpub. data)

**Figure 11.1: A B Incubators Newlife 75 similar to the model used by Adelaide Zoo with Hooded Plover** (Photo Priam Psittaculture Centre website)

The Shore Plover program uses forced air incubators stable (Collen 2014) and these should also be suitable for use with Hooded Plover.


**Figure 11.2: Typical incubator for Shore Plover by Grumbach** (Collen 2014)

## 11.2 Incubation Temperatures and Humidity

**Table 11.1: Typical incubator settings for Hooded Plover** (Craig 1994 Unpub. data)

| Parameter | Value required |
|---|---|
| Temperature | 37. 5ºC |
| Humidity | 63% relative humidity |
| Turning frequency | every 90 minutes (automatic): turning should stop at internal pip |
| Room temperature | 20ºC |

## 11.3 Desired % Egg Mass Loss

Weight loss should be approximately 15% by day 23 – 25 at the time of internal pip (Collen 2014).

## 11.4 Hatching Temperature and Humidity

Temperature: 36ºC
Humidity: 70-75% (Collen 2014, Singor 2012)

## 11.5 Normal Pip to Hatch Interval

From the time of the first fracture it usually takes less than 24 hours, but can take as long as 2.5 - 5 days. It may be necessary to consider assisting the chick to hatch after 3 days (Collen 2014).

**Figure 11.3: Hooded Plover hatchling** (Photo: J Loveland).

## 11.6 Brooder Types / Design

Brooders can be made from painted wood, plastic or fibreglass. Most importantly they must be made from smooth, non-porous surfaces so they can be easily cleaned and properly disinfected.
The brooders used for shore plover are fibreglass or timber with a smooth surface.

**Table 11.2 Typical brooder box dimensions for Shore Plover** (Collen 2014)

| Material / application | Dimensions |
|---|---|
| Fibreglass | 150cm x 65cm x 60cm deep |
| Timber: single brood | 120cm x 100cm x 60cm deep |
| Timber: multiple / older broods | 240cm x 100cm x 60cm deep |

They should have a drainage hole (with plug) in one corner of the floor which makes them easy to clean and rinse with a hose.

**Figure 11.3: Brooders used for Shore Plover** (Collen 2014).

Brooders must have soft-netting lids available to use once the chicks are larger and nearing fledging, to prevent them jumping out of the brooder. The brooder should be lined with a non-slip brooder matting brooder matting that has small holes that faeces can drain through to protect the chick from foot damage and to enable easy cleaning. Towels tend to become soiled. There should be no loose/raised edges or folds, chicks must not be able to find a way under the matting where there is the potential for them to get injured (Collen 2014).

## *11.7 Brooder Temperatures*

Chicks must be kept warm for at least the first 14 days. The temperature at chick level must be monitored closely using temperature probes or thermometers, to ensure chicks do not get chilled or overheated. Brooder heating should be set up and run for a few hours before the chicks are introduced, to ensure the temperature is correct. In addition to the brooder heating described below, the brooder room temperature should be maintained at 20 ºC (Collen 2014).

**Table 11.3: Brooder settings for Shore Plover** (Collen 2014)

| Time post hatching | Brooding instructions |
|---|---|
| Day 1-5 | 35> 32 ºC<br>This stage may be achieved using a ceramic heat lamp hung over the brooder floor and/or electric heat pads placed under the brooder matting. Heat lights are no longer best practice due to the unnatural constant light.<br>The temperature on the brooder floor should be 35ºC on Day 1, |

| Time post hatching | Brooding instructions |
|---|---|
| | gradually reducing to 32ºC by Day 5. The chicks tend to gather under the heat lamp to gain the maximum available heat. Heating must be left on 24 hours a day, providing continuous heat over this stage. During these first few days, larger brooders can be divided in half, if there is concern that the chicks might stray too far from the heating and become chilled. |
| Day 6 – 10 | 32> 25 ºC<br>The temperature on the brooder floor should reduce gradually from 32ºC on Day 6 to 25ºC by Day 10. This reduction in temperature is achieved by raising the heat lamp, or switching to a larger heating element suspended from the ceiling over the brooder. The immediate area heated is approximately one-third to one-half of the brooder, offering refuge from heat over the remaining brooder area. Temperature is reduced further by raising the element over the brooder by rope/pulley and tying it off. |
| Day 14 - 35 | 15 – 20 ºC<br>Chicks should be able to thermoregulate efficiently at room temperature from Day 14. If cold nights are predicted heat must be provided overnight to keep the room temperature at 15-20ºC. Gradually reduce the room temperature to 15 below 20ºC to prepare the chicks for the outdoor environment. |

## *11.8 Diet and Feeding Routine*

The three captive born Adelaide Zoo chicks that data is available for were fed the following diet understood to be between three chicks, for at least the first 15 days (Craig 1994 Unpub. data):

- Blend the following ingredients to achieve a uniform consistency;
- 2 hard boiled eggs
- 30 grams breadcrumbs
- 90 grams Wombaroo Insectivore mix
- Live meal worms and termites

The following routine is used for up to three Shore Plover chicks. Hooded Plover are larger birds, and tend to have smaller clutches so quantities might need review.

**Table 11.5: Feeding routine for Shore Plover chicks** (Collen 2014)

| When | Food to be given twice per day (per 3 chicks) |
|---|---|
| Day 1 - 10 | Selection of live aquatic invertabrates<br>50 grams minced meat<br>Wombaroo insectivore mix<br>Directly onto a flat tray, with added water to make it runnier than adult mix (less likely to dry out under heat lamp)<br>50 grams very finely blended soaked pet crumbles<br>75 small size mealworms, dusted with a calcium supplement and sprinkled over artificial diet |

| When | Food to be given twice per day (per 3 chicks) |
|---|---|
| Day 11-20 | As day 1-10 but change mealworms to medium size and present in a small plastic bowl in a saltwater bath (latter to mitigate bumblefoot risk) |
| Day 20-35 | As day 11-20 but use ceramic bowl (similar to adults)<br>Increase mealworm size to large. |

## 11.9 Pinioning Requirements

Hooded Plovers do not need to be pinioned, the birds at Adelaide Zoo have generally been left un-pinioned, except for two individuals. The reason why these two individuals were clipped was possibly in response to stress or difficulty catching them for treatment (L. Ellis 2014 pers. comm.).

## 11.10 Data Recording

Chicks and brooder temperatures must be checked three times per day. Chicks must be weighed (in a small container lined with matting and placed on electronic scales) daily until 20 days old, then every second day thereafter to 35 days old, to ensure the chick is developing as expected. Chick weights normally drop slightly during the first two days after hatch, but start to increase again once they become mobile and start feeding. By day three they should begin to gain weight and thereafter gain approximately 1.6 g per day until fledging (Collen 2014, Buick and Paton 1989).

## 11.11 Identification Methods

Birds should be banded just before fledging (Collen 2014).

## 11.12 Hygiene

Strict hygiene is required and staff must wash their hands with anti-bacterial hand wash before feeding or handling chicks. All surfaces within the brooder must be thoroughly cleaned every 1-2 days with hot water, then disinfected, rinsed and air dried for 24 hours before re-use. Chicks should be transferred to an alternate brooder during the cleaning cycle (Collen 2014).

## 11.13 Behavioural Considerations

Imprinting is not normally an issue in *Charadriiforme* species, as they are precocial and innately disposed to recognise their parent very soon (within a few hours) of hatching after which time the risk of imprinting is reduced. At the time of hatching in the incubation – hatcher unit they are more likely to associate with siblings or conspecifics. However, habituation to humans might occur and if birds are destined for release to the wild then human contact must be kept to a minimum (White & McMaster 2005).

## 11.14 Use of Foster Species

King Quail were successfully used to complete the incubation of a batch of Hooded Plover eggs rescued from floodwaters in Western Australia, as their eggs are similar size (Singor 2012).

## *11.15 Transition to adult diet*

Fledglings can be transitioned directly from the diet tabulated above onto the normal adult diet without any special intervention (Collen 2014).

## *11.16 Reintroduction to the Wild*

### 11.16.1 Release site selection

Several plovers have been subject to successful captive release programs, and based on these programs the following advice has been prepared for Hooded Plovers. It is recommended that release sites should be situated near areas with existing populations but not released into breeding pairs territory (White & McMaster 2005). Locations that minimize exposure to predators and human disturbance but allow access for post-release monitoring should be favored. Given knowledge of the life history and threats to Hooded Plover release in April-May outside of the breeding season, when beaches are relatively undisturbed and a few months before the breeding season recommences appears prudent (pers. obs.).

### 11.16.2 Release Type

There are two types of releases common used in reintroduction programs:

1. Hard release – no preparatory training, environmental acclimatization or supplemental resources provided
2. Soft Release –a period of time to acclimatize to the new environment is provided

The following 'soft release' protocol for the Piping Plover is recommended as the basis for Hooded Plover release (White and McMaster 2005):

- Release sites for plovers should be a location within historical Hooded Plover breeding habitat. The area should facilitate ease of monitoring, an area that allows for post release surveying, a location where released young can associate with wild plovers (Powell *et al.*. 1997)

Criteria for release to be attempted:

- No current or forecasted poor weather (not cold, no high winds or excessive rain)
- Birds are healthy and are able to fly.
- Birds should be at least 35 days of age.
- Birds should have been trained in flight pens for at least 14 days
- Birds respond appropriately to predators
- Predators are not in the immediate area of release.
- Sufficient staff on hand to react if problems occur.

Release process:

- Record bird ID and complete a final post transport / pre-release physical check of each bird for release.
- Release the birds and retreat

### 11.16.3 Post- Release Requirements

For the first three days post release, feed young according to (slightly less than) the pre release feeding schedule (e.g. 90%). If observations indicate birds are not using supplemental food, feeding may be stopped. If individuals are still using the

supplemental food after three days post release reduce the food amount by 50% to decrease dependency on the supplemental resource (White and McMaster 2005).

Overall captive release programs can have varying degrees of success therefore it is critical to monitor individuals after their release. Post release observations and monitoring are critical to determine if released birds are adapting to natural conditions. The release site and surrounding shoreline habitats should continue to be surveyed for released plovers. Band combinations, apparent health, location and any additional information should be recorded (White and McMaster 2005).

## Acknowledgements

My thanks to all those who assisted me with the preparation of this manual. Particular thanks to Loren Ellis of the bird department of Adelaide Zoo for allowing access to the Hooded Plover exhibit and answering my many questions, to Rose Collen of DOC New Zealand for providing information on the Shore Plover captive breeding program and for many helpful comments on my draft manual, and to Maggie Watson of Charles Sturt University for supervising my project and being ever supportive.

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A copy of the unpublished ZIMS database records for the Hooded Plover's kept at Adelaide Zoo was provided and analysis of this has been the source for much of the data on the captive population.

Lumsden, Lindy. 2014. Wildlife Ecology Section Manager, Arthur Rylah Institute, Department of the Environment and Primary Industries, Victoria, Australia

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# Appendix A Supplier Details

Bird Holding Bags & weigh scales
The Australian Bird Study Association
PO Box 1867
Penrith BC
NSW 2751
Australia
http://www.absa.asn.au/index.php/recoveries/buy-research-equipment

Wombaroo Insectivore Mix
Wombaroo Food Products
PO Box 151
Glen Osmond
South Australia 5064
Australia
http://www.wombaroo.com.au/

A B Incubators
Priam Parrot Breeding
2 Australis Place
Queanbeyan
NSW 2621
Australia
http://www.parrotbreeding.com.au/equipment-technologies/ab-incubators-brooders/

Disinfectants
Virkon:
Lienert Australia
8 Roseworthy Rd
Roseworthy
South Australia 5371
Australia
http://www.lienerts.com.au
Anistel:
LBS Biotech Australia
PO Box 187
Mascot
NSW 1460
Australia
http://lbsbiotech.com.au