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SUCCESSFUL PROTECTION AGAINST CANID PREDATION ON LITTLE PENGUINS (*EUDYPTULA MINOR*) IN AUSTRALIA USING MAREMMA GUARDIAN DOGS: 'THE WARRNAMBOOL METHOD'

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The Little Penguin (*Eudyptula minor*) is the world's smallest penguin, weighing up to 1.2 kg. It lives in coastal environments along southern Australia and New Zealand and breeds on sand dunes and rocky outcrops of islands and mainland sites where it can be safe from predation. Little Penguins have bred on Middle Island, Warrnambool on the Victorian coast in Australia for at least 60 years. In 1999 a survey found 342 active penguin burrows and a population of over 500 adult penguins breeding on the island. The colony was then subjected to intense predation by the introduced Red Fox (*Vulpes vulpes*), so that by 2005 only four birds were recorded arriving on the island to breed. Fox control methods proved ineffective and the colony seemed doomed to extirpation. However, since introduction of Maremma guardian dogs to the island in 2006, there has been an apparent cessation of fox predation of the island's seabirds. This has facilitated a steady increase in the number of penguins breeding on the island. Data on the colony's recovery are presented as well as a description of critical factors in this successful wildlife management process. Using guardian dogs to help protect threatened but heavily predated populations has become known as "the Warrnambool method for conserving wildlife".

Keywords: Predator management, Population recovery, Livestock guardian dogs, Red Fox, Little Penguin, *Eudyptula minor.*

Introduction

The Little Penguin (*Eudyptula minor*) is the world's smallest penguin, weighing up to 1.2 kg (Stahel and Gales 1991). It is endemic to temperate seas in Australia and New Zealand. *E. minor* enjoys high

community appeal, as evidenced by the 483,000 visitors to the penguin parade at Summerland Peninsula, Phillip Island, in 2011-12 (Phillip Island Nature Parks 2012).

Little Penguins feed at sea but breed and moult on land, using burrows dug into dunes, under vegetation or between rocks. The IUCN Red List classifies the species as 'least concern but population declining' (Ellis *et al*. 2005; Birdlife International 2012). This decline has been attributed variously to human interference and burrow trampling (Reilly 1977; Dann 1992; Overeem and Wallis 2003), predation by introduced canids (Reilly 1977; Dann 1992), habitat loss (especially to residential development) (Harris and Bode 1981) and oil and plastic pollution (Overeem and Wallis 2003).

A population of Little Penguins established perhaps in the early 1900s on Middle Island, offshore of Warrnambool, approximately 260 km west of Melbourne, Victoria, Australia. The island has an area of approximately 1.5 ha at high tide mark and is bounded by an intervening channel to the island's eastern side (Fig. 1). The island has a flattened upper surface about 17 m above high tide and is vegetated with salt tolerant shrubs and grasses, including introduced species such as African Boxthorn *Lycium ferocissimum* and Mirror Bush *Coprosma repens* (Overeem 2000).

Figure 1. Middle Island, Warrnambool, Victoria, Australia. Courtesy Warrnambool City Council.

Whilst the island was originally separated from the mainland by higher sea levels, construction of coastal infrastructure and resultant changes to the bay's natural sediment flow-through processes have resulted in sedimentation of the area surrounding the island. The island now lies only approximately 75 m from the coast, allowing easy access for humans and predators during low tides.

Middle Island Management

Middle Island is part of the Thunder Point Coastal Reserve and is managed by the Warrnambool City Council (WCC), the municipal government authority. Warrnambool has approximately 300,000 tourists per year with a peak time in summer, coinciding with when the penguins come ashore to breed. Public access to the island has traditionally been unrestricted, with many visitors crossing to the Island during summer to fish, see the penguins, enjoy the scenery or to jump from the Island's 'jump rock' into the sea below. Visitors have also been observed taking dogs to the Island (Overeem and Wallis 2003). In one four hour sampling period in January 1995, some 265 visitors were seen crossing to Middle Island (Overeem and Wallis 2003).

The Middle Island Penguin Colony

During the spring/summer breeding season Little Penguins feed during the day (unless they are in a burrow sitting on eggs or guarding chicks) and come ashore shortly after dusk. In January 2000, 502 Little Penguins were recorded arriving at Middle Island at the six 'landing' sites. From counts undertaken subsequently, this was estimated to equate to a possible colony size of over 800 birds. Furthermore, there were 342 burrows showing distinct signs of penguin activity (recent footprints, scats, etc.) (Overeem and Wallis 2007).

In recent decades, uncontrolled human access has had an impact on the penguins. For example, a 2000 survey found that 16% of hatching failures and 33% of failures to fledge were directly attributable to inadvertent trampling of burrows by humans. Nonetheless, breeding success was high with 1.49 chicks fledged per breeding pair; a pair usually laying two eggs per breeding attempt (Reilly and Cullen 1971). Double clutching in some pairs (two sets of chicks per breeding season) contributed to this high productivity.

In 2002 WCC built a fenced boardwalk on the Island (see Figure 1) to limit visitors roaming over the whole of the surface and trampling burrows. Forty wooden nest boxes as well were placed at suitable sites. Nonetheless, penguin viewing was uncontrolled and not monitored.

Canid Predation on Penguins

Little Penguin mortality from fox predation has been recorded on Middle Island since at least the early 1990s. Dogs have also accompanied visitors to the Island until access was banned in 2006 and may have killed some birds. It is unknown if dogs have independently swam to the Island and preyed on the penguins.

However, the most significant losses have been through fox kills, identified by characteristic bite marks to the neck. Foxes have been observed swimming to the Island and are believed to have been responsible for a number of penguin deaths almost every year since 1993 (King 2007). The frequency and severity of kills has increased steadily since this time, peaking in 2005 when a staggering 268 penguin carcasses were found in a single day (Overeem and Wallis 2007).

This sustained series of predation events impacted severely upon the colony, causing numbers to crash from a peak of 502 penguins arriving one evening during the 1999-2000 season to only four arriving during the same period in 2005. The number of burrows that showed signs of penguin activity also declined dramatically. While other causes of population decline might have operated (e.g. low food availability, human interference), Overeem and Wallis (2007) concluded the overwhelming reason was fox predation.

Foxes have been reported as significant predators of Little Penguins elsewhere in Australia (Reilly and Cullen 1971; Lade *et al*. 1996] as has their behaviour of killing surplus to needs, which Short *et al*. (2002) attributed to naïve prey (i.e. prey that is unfamiliar with the predator and which has not evolved predator avoidance behaviours). Foxes also cache food from surplus kills in times of food uncertainty, changes in prey vulnerability, securing food against competitors or in training young foxes (Saunders and McLeod 2007).

Predation by foxes is listed as a key threatening process under Commonwealth legislation (Olsen *et al*. 2006) and as a potentially threatening process under State (Victorian) legislation (DSE 2012). This listing is a direct result of the major impact fox predation has had on native mammals and ground-nesting birds in a critical weight range of 35 to 5500 g (Saunders *et al*. 1994).

It is possible some penguins were killed by domestic dogs, although the surplus kills and characteristic bite marks strongly indicate most penguins were killed by foxes. Certainly dogs have been previously reported elsewhere preying on Little Penguins (Stephenson and Woehler 2007).

Previous Fox Management at Middle Island

WCC implemented a range of fox control measures between 2002 and 2006, including employment of a professional shooter. While a few foxes were killed this way, the time delay in information on penguin kills and organising the shoot often meant the fox had moved away from the Island by the time hunts were implemented. In 2005, 15 foxes were shot, including nine females. One fox was shot whilst crossing to the Island. Some 30 fox dens on the mainland near the Island were also fumigated.

Control measures did not stop fox predation of the island's seabirds. In 2003 around 100 Little Penguins and Short-tailed Shearwaters were killed by foxes, including 17 penguins over two nights. In the same year 52 fox scats were collected near the Island, with four containing penguin feathers. In 2004, 500 penguins and shearwaters were believed to have been killed by canid predators respectively. In the following year, 50 penguins were killed (King 2007).

The Middle Island Maremma Trial

Certain breeds of dog (*Canis familiaris*) have been used as guardians for the protection of livestock for possibly thousands of years (Rigg 2001). In the USA a review found predation on farms was reduced by up to 70% with the use of guardian dogs (Coppinger *et al.* 1988). In Australia, they have been used mainly to guard sheep, goats, deer, alpacas and poultry against predation by foxes, wild dogs and birds of prey (van Brommel 2010). The dog breed most used is the Italian Maremmano-Abruzzese or Maremma, imported originally from the UK (van Brommel 2010).

A local poultry farmer, Mr Alan Marsh, who lives near Warrnambool had been using Maremma guardian dogs to successfully guard his free-range chickens and suggested they might be used to protect the Little Penguins of Middle Island. In 2006, with the colony facing complete extirpation, a trial of the livestock guardian dog technique was proposed. The Middle Island Steering Committee, comprising representatives of WCC, Government agencies, universities, community conservation organisations and Mr Marsh, was convened to oversee the trial.

A media campaign was mounted while approvals were sought. On 30 October 2006, WCC approved a four week trial to be conducted subject to certain conditions being met. On 15 November 2006 the trial began with 'Oddball' (Fig. 2), a guardian dog that had been guarding free-range chickens for a number of years. The Island was closed to the public for this initial trial period.

Methods

A key priority in project planning was identifying appropriate measures and methods for assessing the project's 'success'. The Steering Committee developed a set of key criteria by which to evaluate the trial's effectiveness in mitigating predation. These were:

(1) The number of seabird deaths that could be attributed to canid predation;
(2) The number of penguins recorded breeding on the island, to be measured via a series of regular dusk 'arrival counts';

(3) The colony's breeding success as measured by the proportion of fledged chicks to the number of eggs laid;
(4) Trial-related impacts and interactions; and
(5) The level of public support for and acceptance of the trial.

Figure 2. "Oddball", the Maremma guardian dog used in the 2006-07 Middle Island Maremma Trial.

Number of seabird deaths attributed to canid predation

Fox activity was monitored during the course of the trial via regular inspections of the island and surrounding area for prints and scats. Inspections were undertaken over a total of 170 hours during the four week trial.

Number of penguins breeding on the island

Counts of the number of adult penguins arriving during the nightly 'penguin parade' can be used as a proxy measure to estimate the size of the colony's breeding cohort. An initial arrival count was undertaken on 12 October 2006 prior to Oddball's introduction to the island, with counts then continuing at monthly intervals over the 2007-07 breeding season. Arrival counts were conducted at six penguin entry points around the island for a one hour period from arrival of the first penguin, as at least 60% of all arrivals come ashore within an hour of the first arrival (Dann 1992).

Penguin breeding success

A breeding ecology study commenced on 9 November 2006 and was conducted fortnightly throughout the 2006-07 breeding season. All natural burrows marked during previous studies and artificial nest boxes were checked along with any other accessible burrows that showed signs of penguin activity (e.g. recent digging, scats out front).

Trial-related impacts and interactions

During the trial, dog carers and arrival count volunteers would be accessing the island's top section and occasionally leaving the boardwalk. As human disturbance has impacted upon the colony in the past (Overeem and Wallis 2003), it was determined that the effect of trial workers on the Middle Island environment should be investigated.

'Impact' was defined as any effect that dog or volunteers may exert on the wildlife, vegetation, substrate or geology of Middle Island. Relevant observations were recorded during arrival counts conducted within the trial period. Further information was obtained through discussions with the three aforementioned trial workers. Information collected was used to construct an anecdotal account of interactions between dog, volunteers and the Middle Island environment.

Public support

Public response to the trial was assessed through regular interrogation of journalistic media, international communication through the internet, and the direct actions of local community members. Observations from these three forums were analysed to provide a 'snapshot' of the general public's response to the trial, including the Warrnambool community's response to closure of Middle Island. Research into public response commenced 30 October 2006 with the trial's initial public announcement and continued until mid-May 2007. Local response to the trial was investigated via interviews with trial workers and daily searches of local newspaper 'The Warrnambool Standard'.

Results

Number of seabird deaths attributed to canid predation

No foxes were observed on the island during the trial, although there was some evidence of fox presence on the adjacent mainland beach. A number of foxes were also seen in nearby Stingray Bay before and after the trial. The absence of recorded fox kills during the 2006-07 breeding season was significant given that regular and often severe predation events had occurred on the island every year since 1999.

Number of penguins breeding on the island

The number of penguins recorded arriving on the island during the first count was 29. This number peaked at 70 on 8 December 2006 and declined to three birds on 19 February 2007, in keeping with the

Little Penguin's natural breeding season pattern. The trend and dates of arrivals agree with data from previous studies (Overeem and Wallis 2003). Based on the peak arrival count for the 2006-07 breeding season, the number of Little Penguins breeding on Middle Island was estimated to be 116. Figure 3 also indicates the estimated maximum population size for each breeding season from 2000-2001 to 2013-2014 based on arrival count date.

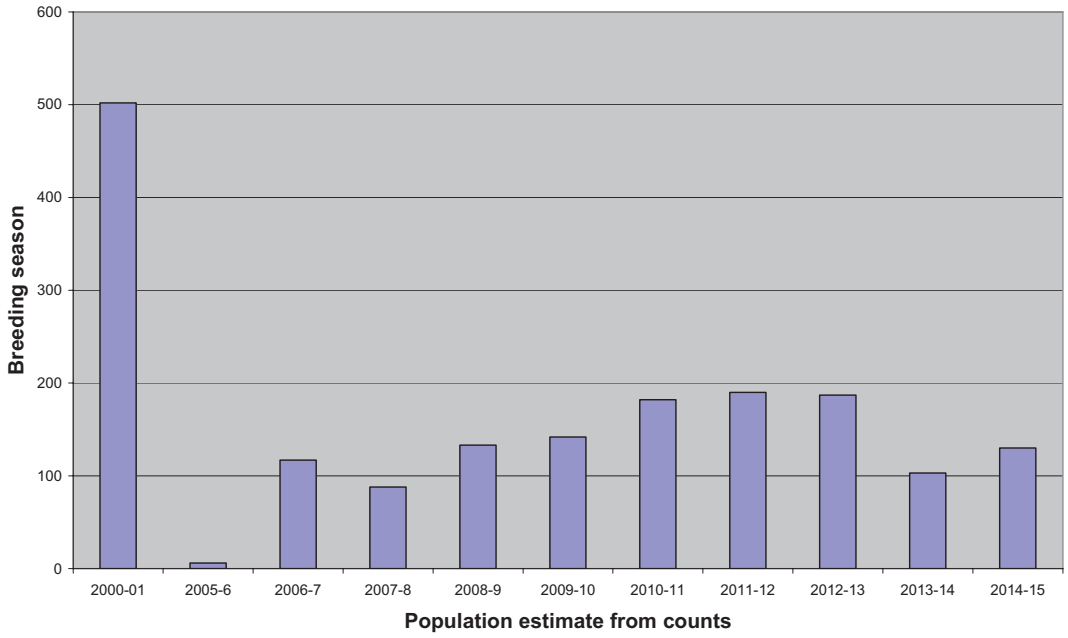

Figure 3. Maximum population estimates of Little Penguins on Middle Island based on arrival counts for the breeding seasons 2000-2001 through to 2013-2014.

Penguin breeding success

At least six pairs were recorded breeding on the Island during the trial (an increase from zero in the previous season). A total of 15 eggs were recorded, 13 (87%) of which hatched. There was a 100% fledge rate from hatching, with all 13 chicks fledged by March 2007.

Trial-related impacts and interactions

One dog-bird interaction was recorded on the first night of the trial in which a penguin attacked when approached by the Maremma. One arriving, the penguin retreated upon seeing the dog, though this was not observed again after the first night. The dog was said to briefly investigate ('approach, sniff and watch') birds on the first night and then apparently lose interest. One dog regularly slept within a metre of a successful penguin breeding burrow. No other negative interactions between dog and birds were observed. During arrival counts, dogs would sit with monitors as penguins arrived. No birds were seen to retreat from the Maremma during the two counts conducted within the trial period (King 2007).

Public support

On a number of occasions members of the public attempted to access the island during its closure, with some people saying they did not know about the trial and were attempting to 'get the dog off the island'. In all cases but one, people left willingly when approached by workers (King 2007). An online survey

conducted by the local newspaper in February 2007 found that 85% of respondents supported island closure for the purposes of the trial, highlighting a strong sense of ownership over the colony and support (Bayne 2007).

Key outcomes of the trial

The four week trial conducted in 2006-07 demonstrated positive results for all five of the assessment criteria investigated. Key outcomes included:

(1) An apparent cessation of seabird deaths attributed to canid predation;
(2) An increase in the number of birds breeding on the island from less than 10 in 2005 to an estimated 116 during the study period;
(3) A high relative breeding success rate, as measured by a recorded hatching rate of 87% and the successful fledging of all recorded hatchlings;
(4) Minimal observed instances of trial-related impacts and interactions; and
(5) A high level of public support for the trial and for the island's closure.

Based on these results, WCC approved a 12-month extension of the trial in June 2007, with the project subsequently approved as an annual program.

Discussion

The Middle Island Maremma Project

Maremma dogs have continued to be used at Middle Island each breeding season with great success. What began as a four week trial has developed into an ongoing program branded the 'Middle Island Maremma Project', and the positive outcomes of the initial trial have been sustained over subsequent seasons. To date, there have still been no recorded instances of canid predation in the study area, facilitating a steady recovery in the number of penguins breeding on the island. An arrival count conducted during the 2012-13 breeding season recorded an estimated 187 penguins arriving on the island, while breeding surveys found 21 chicks to have fledged in 2011-12. Figure 3 shows a decline in population size in the 2013-2014 season and only three chicks fledged; this has been attributed to a warming of nearby ocean waters, especially a reduction in the Bonney upwelling that brings nutrient rich bottom, cold water to the surface of the ocean. Such a reduction in the upwelling reduces the availability of small fish for the penguins. The arrivals of penguins then increased in the following season as more normal climatic conditions returned. Twelve chicks fledged this season.

Warrnambool City Council has spearheaded the project, providing strong administrative and financial support since its inception. The Council, along with businesses operating in the region, have provided funds for the dogs' training, care and housing, and have employed a person who has responsibility for the dogs during the penguin breeding season.

Since the 2006-07 trial, the community has continued to show a high level of support for the project and for the island's closure. Members of the public have also supported the project by reporting illegal activity on the Island. Public support has been maintained through the delivery of annual "Meet the Maremma Tours' and through media attention at the local, national and international levels. The local newspaper has continued to give prominence to stories on the decline of the penguin colony and has kept readers up to date with management actions to conserve the colony. The newspaper has also conducted readers' competitions to name the dogs used in the project.

The project has relied heavily on the contributions of local volunteers. Warrnambool Coastcare Landcare Group volunteers have undertaken more than 100 fortnightly breeding surveys and arrival counts, contributing over 4,000 volunteer hours since the project's inception. The program has also seen the involvement of hundreds of volunteers from the local community, Government agencies and the Deakin University Warrnambool campus.

Challenges

The most significant challenges for the project have related to care, training and management of the Maremma dogs. Of the five dogs used over the project, two needed to be replaced after escaping from the Island and travelling several kilometres along the coast. It appeared they were following the scent of a fox, judging by the pattern of dog and fox footprints found. Another pair of dogs is thought to have killed penguins after what a vet deemed as playful behaviour. The penguin carcasses were intact and showed bleeding in the internal organs, injuries consistent with being picked up by the dogs. The birds had not been eaten and fox predation was ruled out. These dogs were subsequently removed from the island.

Research has demonstrated that while up to half of young guardian dogs may inadvertently injure livestock within their first year, most undesirable behaviours can be corrected over time (Rigg 2001). Problems with guardian dogs elsewhere have been aggression towards humans, harassment and injury to livestock, wandering outside the boundaries and preferential bonding with humans instead of the animals they were meant to guard (Rigg 2001).

At Middle Island, the Maremmas have both injured the penguins (twice) and wandered from the Island (twice). The potential for dogs to wander from the island or cause injury or disturbance to seabirds may be minimised by careful puppy selection, monitoring, appropriate training and prompt behaviour correction (Rigg 2001). Furthermore, research has shown that it may take up to 2 years for young guardian dogs to become effective at deterring predators (Rigg 2001); thus predator presence should be continuously monitored during future programs.

Other challenges relate to the ongoing need for fox control within the surrounding precinct to complement the program, and the need to secure ongoing resources and support for the project's implementation. Whether WCC continues to fund the program in the interests of conserving an iconic local species remains to be seen. However, use of the Maremmas will need ongoing financial support. For instance, the initial trial cost approximately AU$10,000, with the major cost being the employment of a dog handler/carer. It is unknown whether the program could be maintained should WCC cease provision of funding.

Application as a wildlife conservation tool

No fox kills have been recorded on the island since introduction of the Maremmas in 2006. This is particularly significant given that the island's seabirds had suffered at least 14 years of sustained and severe predation events prior to the trial. The penguin colony, estimated at less than 10 birds in 2005, has exhibited a remarkable recovery in the absence of predation, with peak arrivals increasing at an average rate of approximately 12 birds/year.

Several studies have demonstrated that threatened populations can recover when predators are excluded (Butchart *et al*. 2006; Donlan and Heneman 2007), and the Phillip Island experience has shown that predator control can increase the distribution of ground-nesting birds (Bloomfield 2008).

It is suggested that this technique may prove to be a highly useful and effective tool for the conservation of threatened seabird populations. The guardian dog technique may also have applications in other settings – for example, at wildlife shelters and reintroduction programs where locally extinct species are released back into the wild. Thus Melbourne Zoo has commenced a trial using Maremma guardian dogs to protect the critically endangered mainland population of the Eastern Barred Bandicoot.

The technique of using guardian dogs to protect heavily predated populations in danger of extirpation has become known as "the Warrnambool method for conserving wildlife".

Conclusion

Maremma guardian dogs have been successfully used to protect a breeding colony of the Little Penguin on Middle Island, in south-western Victoria, Australia. There has been an apparent cessation of fox

predation since Maremmas were introduced, while a concurrent steady increase in the number of penguins breeding on the island has been observed. Thus during the life of the project from 2006-2014 there have been no known incidents of fox predation of Little Penguins on Middle Island. In contrast, prior to the introduction of Maremmas, fox predation was a regular and yearly occurrence for the period including 2000- 2005. This suggests that the use of livestock guardian dogs can be an effective tool for preventing fox predation of native wildlife.

Critical reasons for the success of this program have included strong support from the Warrnambool community, the local Council, businesses and volunteers. Some penguin deaths have thought to have resulted from the dogs and two sets of dogs have left the Island, but modifications to dog training, care, housing and handling have overcome these difficulties. The challenge is to maintain the program into the future with ongoing funding, community enthusiasm and local government support.

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