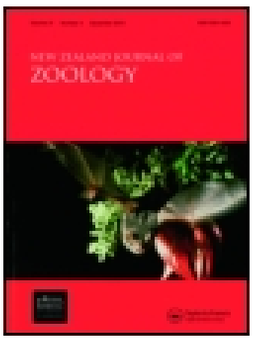

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# Behavioural responses and attraction of New Zealand sea lions to on-land female decoys

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Using decoys to attract gregarious animals is a common management practice, but rarely used for pinnipeds. We investigated the behavioural responses of New Zealand (NZ) sea lions, *Phocarctos hookeri*, at Sandy Bay, Enderby Island, to determine whether decoys can attract female sea lions and so could be useful for the establishment of new colonies. We deployed decoys near existing breeding aggregations for 4 hours at a time. One or a group of three artificial decoys, made of white fabric, attracted up to 54% of females coming ashore, of which 73% came close enough to sniff the decoys. Up to 62% of males coming ashore within 15 m either side of these decoys moved towards them. A single taxidermied female NZ sea lion did not attract females significantly more often than a single fabric one, but was investigated as if alive by males. It appears that female NZ sea lions are attracted to decoys by their colour, at least when located close to an existing group of females. A technique using decoys could be trialled to direct recolonising females to suitable pupping sites.

**Keywords:** New Zealand sea lion; decoy; attraction; management; recolonisation; pinniped

## Introduction

Using decoys to attract wild animals to a specific site is a common practice, especially for gregarious species (Sharp and Lokemoen 1987; Story 1991). Decoys are also used as tools in research on social and anti-predator behaviours (e.g. in birds [Romero et al. 1997; Stenhouse et al. 2005]), and mate attraction and gregarious behaviour (e.g. in insects [Hall 1988; Otis et al. 2006]). Wildlife managers have used decoys to manage interactions between humans and wildlife (e.g. to limit the damage done by starlings in berry farms in Europe [Conover & Dolbeer 2007]).

The use of decoys relies mainly on the fact that animals have search images including specific elements of what they seek. As soon as this search image is recognised, individuals make appropriate responses, which will be positive if the search image is associated with safety, a potential mate or food (Inglis & Isaacson 1984; Blough 1989). Many pinniped species are highly gregarious (i.e. attracted by each other) at least during the breeding season (Boness 1991), but we know of only one example of the use of decoys with this group: Deutsch et al. (1990) used a decoy of a female elephant seal to attract males within close range (50 to 100 m) onto a flat weighting platform. The possible use of decoys to study pinnipeds' social behaviour, or attempting to attract them onshore, has never been investigated.

New Zealand sea lions (NZ sea lions), *Phocarctos hookeri*, are mostly philopatric colonial breeders. The same sites are used for breeding colonies every year (Chilvers & Wilkinson 2008). In these breeding aggregations, females form a high-density group through which territorial males are scattered,

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each defending a territory and the females within it (Marlow 1975). Outside the breeding aggregation, peripheral adult males and sub-adult males may cause injuries or death to females (Chilvers et al. 2005).

All mainland breeding colonies of NZ sea lions were wiped out by the 1830s (Childerhouse & Gales 1998). The species is listed as threatened by the IUCN, and is classified as a Priority 1 (highest) species by the Department of Conservation (DOC). One of the reasons for both rankings is the low number of breeding colonies (Suisted & Neale 2004; IUCN 2004); only three remain today, all in the sub-Antarctic islands of New Zealand (north Auckland Islands, Figure of Eight Island and Campbell Island [Robertson et al. 2006; Maloney et al. 2009]). The possible establishment of new breeding colonies within the historical breeding range (the New Zealand mainland) is a major advance that could eventually remove this species from its threatened status (Department of Conservation, 2009). However, the human population on the New Zealand mainland has significantly increased since the 1830s and may threaten the recolonisation process. Stevens & Boness (2003) recorded that established breeding colonies of South American fur seals, *Arctocephalus australis*, were abandoned because of high levels of human disturbance. Therefore, a better understanding of the behavioural processes underlying how female sea lions choose where to come ashore to breed would be a useful tool for wildlife managers concerned with the NZ sea lions' ability to recolonise the New Zealand mainland.

In 1993, a lone female NZ sea lion from the Auckland Islands landed on the NZ mainland and has bred there since. Her female offspring have returned to this site, and also started breeding, establishing a population which has, between 1993 and 2009, produced 40 pups, all reared on the Otago Peninsula (45.8° S, 170.7° E [McConkey et al. 2002a; New Zealand Sea Lion Trust 2009). The main areas used by this newly recolonising population on the Otago coastline are within 30 km of the centre of the city of Dunedin.

NZ sea lions are surprisingly agile on land, and tend to move up to 1.5 km inland beyond the breeding beaches (McNally et al. 2001; Augé et al. 2009). In populated areas, this unusual behaviour invites human-sea lion interactions, which have already raised several management issues around Dunedin and the adjacent Otago Peninsula (McConnell 2001; McConkey et al. 2002b). These issues include active disturbance of NZ sea lions by visitors and dogs (Heinrich 1998; McConnell 2001), sea lions shot on beaches, injured or killed on roads (J Fyfe pers. comm.), and sea lions using unexpected places (e.g. a private garden, public car parks, a golf course; J Fyfe pers. comm.). It would be strongly desirable to avoid the same problem now developing along the Kaikoura coast, eastern Marlborough, where growing numbers of New Zealand fur seals, *Arctocephalus fosteri*, are hauling out on beaches within 50 m from a highway, and collisions between them and cars are becoming a significant issue (Boren et al. 2008). All these issues could be minimized for the NZ sea lion if new breeding colonies could be orientated to establish at isolated sites where human presence and roads are uncommon.

With these considerations in mind, we investigated the behaviour of NZ sea lions coming ashore and interacting with decoy female sea lions deployed on a breeding beach. If female New Zealand sea lions are attracted to the decoy, it might be possible to use decoys along the Otago coast or elsewhere to orientate the newly-arriving NZ sea lion females towards the most appropriate sites. By deploying decoy female sea lions on an area of beach with no females, we studied the behavioural responses of males and females at an established breeding colony, during the beginning of the breeding season. Our aims were: (1) to ascertain if decoy females would attract sea lions of either gender to come ashore; (2) to find out which type of decoy was the most effective; and (3) to assess the responses to the decoy and what they revealed about the behaviour of NZ sea lions coming ashore to breeding areas. In the final year, we extended the study to investigate whether the behaviour of NZ sea lions towards the decoys changes as the breeding season progressed.

## Material and methods

### *Study site*

The study site was Sandy Bay, Enderby Island, Auckland Islands (50.5° S, 166.3° E). Breeding NZ sea lions arrive in December and January each year on a 350 m long sandy beach. We made observations during three field seasons: 2006 (5 to 29 December), 2007 (9 to 30 December), and 2008 (11 December to 8 January 2009). The first females (usually a small group between 1 and 3) come ashore in early December. Progressively, females aggregate at this location (Augé 2006), and by 26 December (the mean pupping date [Chilvers et al. 2007]), an average of 350 females formed the breeding aggregation during the study years.

### *Behavioural observations*

Artificial (made of white canvas-type fabric, the size of an adult female [Fig. 1]) or taxidermied (real, stuffed) female decoys were placed 8–25 m from the breeding aggregation. They were deployed on either side (depending on available space on the beach), at the same distance to the waterline as the edge of the breeding aggregation. Because of the dangers for a female being caught and harassed by peripheral males when alone on the beach, we placed the decoys close enough to the breeding aggregation so that any female coming towards them could easily get back to the safety of the group. Three different types of experiments were conducted separately, using (1) one artificial decoy, (2) a group of three artificial decoys, and (3) one taxidermied decoy.

**Fig. 1** Photograph showing an artificial decoy (made of white canvas type fabric) (left), and a live female New Zealand sea lion (right), at Sandy Bay, Enderby Island, Auckland Islands, in December 2008 (photo N. McNally).

We deployed the decoys for observation periods of 4 hours at a time (from 8:00 to 12:00, 12:00 to 16:00 or 16:00 to 20:00, with an equal ratio across the entire study), and watched them from a hide overlooking the beach. The deployment of the decoy females was weather dependent because we did not conduct any observations when visibility was limited by heavy rain or thick mist. We drew a circle in the sand with a radius of 5 m from the decoys, because the males' territories usually extended c. 2 m around themselves, named hereafter the 5 m radius area. The number of NZ sea lion females in the breeding aggregation and the presence of males within the 5 m radius were recorded at the start of each observation period. The males in the 5 m radius were mostly inactive, but were observed if they later actively moved towards the decoys.

We divided the beach into zones as shown in Fig. 2, each defined to reflect our question. The zone with the breeding aggregation covered the shoreline behind which the breeding aggregation was found. Zone B and Zone with decoys were the shorelines 30 m on each side of the edges of the breeding aggregation. Zone B was the control zone without decoys, Zone with decoys was the experimental zone where the decoys were deployed. Zone A was the rest of the beach on the side of Zone B opposite to the breeding aggregation, Zone C, the rest of the beach on the side of the Zone with decoys opposite the breeding aggregation. Both Zones A and C were the shorelines that started 30 m from the edges of the breeding aggregation until the end of the beach on each side. Zones with breeding aggregation, A and C varied in width depending on the spread and location of the breeding aggregation on the beach. Zones B and with decoy were always 30 m in width.

Because males were numerous, spread along the entire beach, and kept moving in and out of the water, we used different methods to record the behaviour of the two sexes.

For females, we recorded the numbers and locations of females coming ashore anywhere on the beach in relation to the zones. By recording the number of females coming ashore

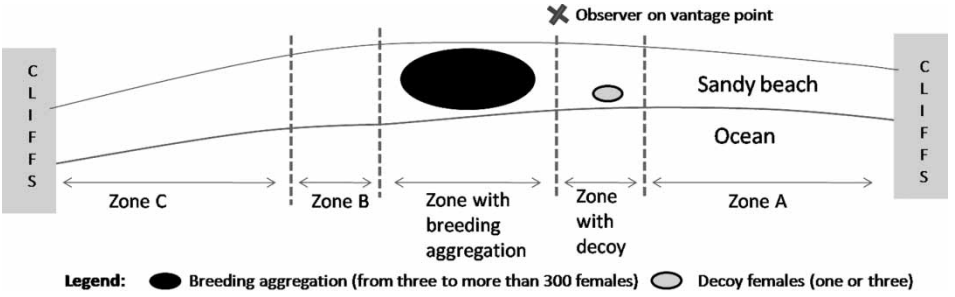


**Fig. 2** Description of the zones used to record where female New Zealand sea lions came ashore during behavioural observations using decoy females at Sandy Bay, Enderby Island. The decoys were placed on either side of the breeding aggregation, changing the zones accordingly so that zone B is always the opposite side of the breeding aggregation to the zone with decoys. Both are 30 m width at all times. The widths of the other zones depended on the location and spread of the breeding aggregation.

in each zone, we could compare the results between the Zone with decoys and Zone B that should receive the same rate of visits by female NZ sea lions if there was no effect of the decoys. We also observed the interactions of females with the decoys. We recorded when a female went within the 5 m radius (which we defined as being attracted to the decoys), duration of contact with the decoys, if they called for a pup, and the number of times a female appeared to sniff the decoy. Sniffing was defined as the behaviour of a sea lion pulling its head towards the decoys and putting its snout close to the decoy. This is a natural behaviour exhibited by all age-classes of sea lions and is likely to be related to olfactory individual recognition (Bowen 1991).

We split males into two age classes: adult males (fully developed breeding males with large manes) and sub-adult males (smaller and lacking a large mane). It is important to note that the size and development of a male does not always match his age (e.g. one tagged 14 year-old male was the size of a typical 3 or 4 year-old male with no developed mane: A Auge pers. obs.). There were numerous males along the beach and they continuously moved on the beach and in and out of the water, making it difficult to keep accurate track of how individual males moved around the decoys. We consequently recorded the number of males (adults and sub-adults) coming ashore within the Zone of decoy and the portion that went directly to the decoys. We also recorded the total number of males that went to the decoys by walking along the beach, the portion that sniffed the decoys, how many times they sniffed the decoys, and other behaviours indicating interest in the decoys. Some of the males recorded as going to investigate the decoys may have been the same ones that left and later came back during the same observation period, but we had limited means to distinguish individuals.

The main difference between artificial and taxidermied decoys is their colour (Fig. 3). Real female NZ sea lions are grey to light brown on their back and light grey to white on the belly, whereas the artificial female decoys were entirely white. Both types of decoys had approximately the same size, position (resting), and shape. We hypothesised that colour plays a role in the search image of female NZ sea lions coming ashore. By comparing the behavioural responses of females to one artificial and one taxidermied decoy, we can test this hypothesis. We did not test if female NZ sea lions would be attracted to other decoys of various colours because male NZ sea lions were scattered all along the beach (Fig. 3). Their colours range from light brown to black and they vary in size from smaller than an adult female to three times the size of a female. These males were considered as a natural experiment testing whether females would be attracted to darker artefacts to come ashore on the beach (i.e. anywhere on the beach if this was the case), and

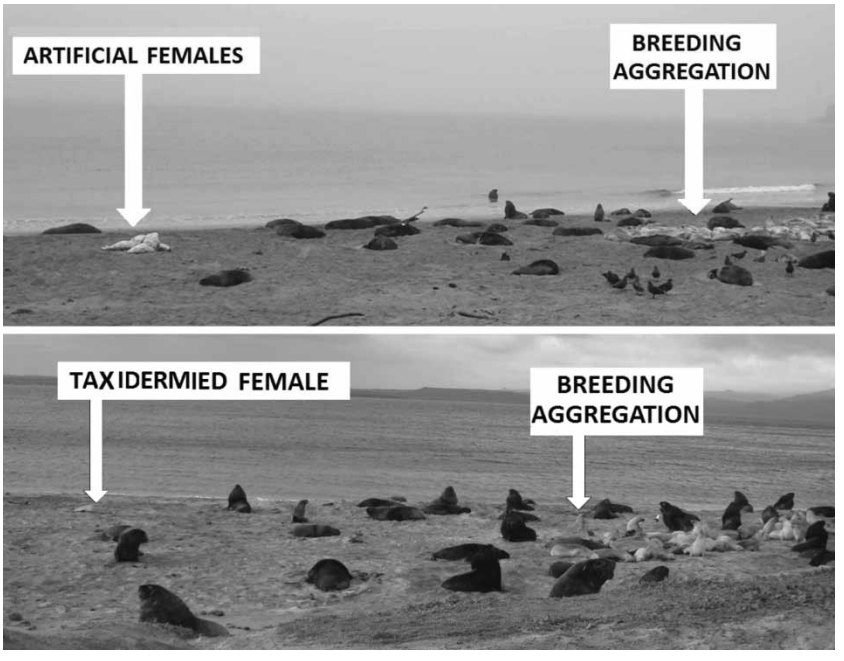


**Fig. 3** Photographs of the group of three artificial female sea lion decoys (made of white fabric; top) and the lone taxidermied female (bottom) deployed beside the breeding aggregation at Sandy Bay, Enderby Island, Auckland Islands. Photo by A Auge.

confirm the significance of the colour for the search image of females coming onshore.

Statistical analyses were conducted using R 2.10.0 and consisted of linear regression models to compare two groups.

### *Behavioural changes in females throughout the breeding season*

In December 2008 and January 2009, we recorded whether female NZ sea lions looked from the water before coming ashore (as shown in Fig. 4). This behaviour was previously described by Chilvers et al. (2005) as searching for a way to avoid male harassment. Breeding female NZ sea lions usually arrive individually at Sandy Bay from the beginning of December until mid-January (Augé et al. 2009). For each female coming ashore, we estimated the chances that she had a pup onshore by recording whether or not she called for her pup once in the breeding aggregation. If she had, this call was usually heard within 30 minutes after she came ashore. Some females might have called later, but we could no longer identify them within the breeding aggregation as their fur had dried. All females calling for a pup must have been previously in the breeding aggregation and given birth there.

Our hypothesis was that NZ sea lion females, who had already been in the breeding aggregation so were about to call for a pup, would less often look from water before coming ashore and were, consequently, less likely to go to the decoys. Therefore, the ability of the decoys to attract female NZ sea lions would decrease as the breeding season progressed and as the number of females that had already landed on the beach increased. Because the stage of breeding of females (whether or not they have been ashore previously) may influence their behaviours and their interest in decoys, we first analysed the effect of behavioural changes throughout the breeding seasons before analysing the other behavioural data.

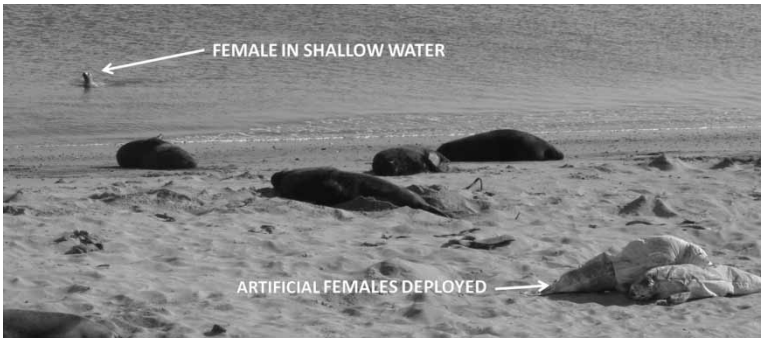


**Fig. 4** An example of a female New Zealand sea lion looking from shallow water towards the artificial females before coming ashore at Sandy Bay, Enderby Island, Auckland Islands. Photo by a A Ange.

## Results

In total, we observed the behaviour of female NZ sea lions for 176 hours, during which time 240 females came ashore. During the formation of the breeding aggregation (prior to 22 December), 77% of females looked towards the beach from shallow waters before coming ashore. Of these females, none called a pup after reaching the breeding aggregation. During the mean pupping period from 23 to 28 December (three days either side of peak pupping date), 36% of females coming ashore looked from the water, and 29% of these called for a pup once in the breeding aggregation. After the mean pupping period (from 29 December to 8 January), only 23% of females looked from shallow water before coming ashore, and 80% of females that did not look from water before coming ashore had a pup in the breeding aggregation. The behaviour of looking from the water indicated that female NZ sea lions assessed the beach from shallow waters before coming ashore. This behaviour significantly decreased after the pupping peak, and this observation was used to choose the date to end our study each year (26 December, before the mean pupping date).

From 6 to 26 December each year, we deployed the group of three white artificial decoys for 36 hours during 2006 and 8 hours during 2007. The lone taxidermied female decoy was deployed for 44 hours in 2007, and the lone white artificial decoy for 44 hours in 2008.

When using one or the group of three artificial female decoys, more female NZ sea lions came ashore in the Zone with decoys than in Zone B (linear regression models of numbers of females coming ashore in Zone B and Zone with decoys, all d.f. $= 1$, $t = 3.63$, $P = 0.002$ with lone artificial decoy, and $t = 6.39$, $P < 0.001$ with group of three artificial decoys). Tables 1 and 2 show the results of the observations for each day. No female was seen coming ashore in Zone A, while only three females came ashore in Zone C during the study. Most females that came ashore in zones other than the Zone with breeding aggregation walked along the beach to the breeding aggregation or went back to water. Female NZ sea lions seemed attracted to the artificial female decoys, with only a nominal difference between the group of three decoys (when the three decoys were deployed 54% of females came ashore in the Zone with decoys) and the lone decoy (when the lone decoy was deployed 48% of females came ashore in the Zone with decoy). Consequently, both the group of three and the lone artificial decoys attracted females onshore.

When using the taxidermied female decoy, seven NZ sea lion females (15% of the total of females coming ashore) came ashore in the Zone with decoy (Table 3), but the attractive effect was not statistically significant (linear regression model of numbers of females coming ashore in Zone B and Zone with taxidermied decoys d.f. $= 1$, $t = 1.86$, $P = 0.088$).

Of the females that came ashore in the Zone with artificial decoys, 81% and 50% went within the 5 m radius, respectively for three decoys and the lone decoy. Seventy-three

**Table 1** Number of female New Zealand sea lions coming ashore during 4-hour periods within the different zones during the deployment of a group of three artificial female decoys at Sandy Bay, Enderby Island, Auckland Islands. Zone B and with Zone with decoys were the shorelines 30 m on each side of the edges of the breeding aggregation. Zone B was the control zone without decoys, Zone with decoys was the experimental zone where the decoys were deployed. Zone A was the rest of the beach on the side of Zone B opposite to the breeding aggregation; Zone C, the rest of the beach on the side of the Zone with decoys opposite to the breeding aggregation. Both Zones A and C were the shorelines that started 30 m from the edges of the breeding aggregation until the end of the beach on each side.

| | | Number of females coming ashore in | | | | | |
|---|---|---|---|---|---|---|---|
| Date | Breeding aggregation (number of females) | Total | Zone A | Zone B | Zone with breeding aggregation | Zone with decoy | Zone C |
| 06 Dec 06 | 24 | 3 | 0 | 0 | 0 | 3 | 0 |
| 07 Dec 06 | 6 | 3 | 0 | 0 | 1 | 2 | 0 |
| 13 Dec 06 | 62 | 4 | 0 | 0 | 1 | 3 | 0 |
| 14 Dec 06 | 67 | 2 | 0 | 0 | 1 | 1 | 0 |
| 16 Dec 06 | 85 | 7 | 0 | 1 | 1 | 5 | 0 |
| 20 Dec 2006 a.m. | 185 | 6 | 0 | 1 | 2 | 3 | 0 |
| 20 Dec 2006 p.m. | 191 | 4 | 0 | 0 | 3 | 1 | 0 |
| 20 Dec 2006 evening | 195 | 8 | 0 | 0 | 4 | 4 | 0 |
| 27 Dec 06 | 335 | 6 | 0 | 1 | 1 | 3 | 1 |
| 20 Dec 07 | 147 | 7 | 0 | 1 | 3 | 3 | 0 |
| 22 Dec 07 | 170 | 9 | 0 | 0 | 5 | 4 | 0 |
| Totals | – | 59 | 0 | 4 | 22 | 32 | 1 |
| **Percentages** | **–** | **100** | **0** | **7** | **37** | **54** | **2** |

percent of females that came within the 5m radius sniffed the group of three decoys, and 63% sniffed the lone decoy. On average, females sniffed these decoys $1.3 \pm 0.9$ (mean $\pm$ SE) times, whether there were one or three decoys. The females that went to the decoys spent on average $3.8 \pm 2.8$ mins (maximum of 13 mins) with the group of three decoys and $2.3 \pm 3.3$ mins (maximum 12 mins) with the lone artificial females before returning to the breeding aggregation (linear regression model on the times that females spent with the two types of decoys: d.f. $= 1$, $t = 0.86$, $P = 0.360$). These results exclude two outliers, which were two females who spent 142 and 174 mins with the lone artificial female. The decoy was retrieved while these females were still with it, cutting short these times. Both females stayed together until they joined the breeding aggregation sometime during the night. Of the seven females that came ashore in the Zone with the lone taxidermied female, only one went to the decoy and sniffed it seven times. This female then stayed with the decoy for 68 mins but, as above, this time was not representative as the decoy was retrieved while the female was still with it. Once the decoy was removed, the female returned to the breeding aggregation within a few minutes.

For male NZ sea lions, 11–48% of adults and 37–84% of sub-adults that came ashore in the Zone with decoys during 4 hour-observations went to the decoys (Fig. 5). Overall, adult males did not investigate the decoys with the same intensity as did sub-adult males. Within both age classes of males, the lone taxidermied decoy generated the least interest. The group of three artificial decoys was the most efficient at attracting adult males, while the lone artificial decoy had more effect on the sub-adult males. The total numbers of males that came ashore in the Zone with decoys cannot be compared directly as the observations took place during different days and different years. However, sub-adult males coming ashore in the Zone of decoy were always more numerous than adult males.

**Table 2** Number of female New Zealand sea lions coming ashore during 4-hour periods within the different zones during the deployment of a lone artificial female decoy at Sandy Bay, Enderby Island, Auckland Islands. Zone B and with Zone with decoys were the shorelines 30 m on each side of the edges of the breeding aggregation. Zone B was the control zone without decoys, Zone with decoys was the experimental zone where the decoys were deployed. Zone A was the rest of the beach on the side of Zone B opposite to the breeding aggregation; Zone C, the rest of the beach on the side of the Zone with decoys opposite to the breeding aggregation. Both Zones A and C were the shorelines that started 30 m from the edges of the breeding aggregation until the end of the beach on each side.

| | | Number of females coming ashore in | | | | | |
|---|---|---|---|---|---|---|---|
| Date | Breeding aggregation (number of females) | Total | Zone A | Zone B | Zone with breeding aggregation | Zone with decoy | Zone C |
| 10 Dec 2008 | 12 | 1 | 0 | 0 | 0 | 1 | 0 |
| 17 Dec 2008 | 35 | 1 | 0 | 0 | 0 | 1 | 0 |
| 18 Dec 2008 | 51 | 5 | 0 | 1 | 2 | 2 | 0 |
| 19 Dec 2008 | 62 | 4 | 0 | 0 | 1 | 3 | 0 |
| 20 Dec 2008 | 94 | 6 | 0 | 0 | 1 | 5 | 0 |
| 21 Dec 2008 p.m. | 99 | 3 | 0 | 0 | 3 | 0 | 0 |
| 21 Dec 2008 evening | 101 | 7 | 0 | 1 | 2 | 4 | 0 |
| 22 Dec 2008 | 111 | 6 | 0 | 0 | 5 | 1 | 0 |
| 23 Dec 2008 p.m. | 137 | 6 | 0 | 0 | 3 | 2 | 1 |
| 23 Dec 2008 evening | 143 | 4 | 0 | 0 | 1 | 3 | 0 |
| 24 Dec 2008 | 168 | 3 | 0 | 0 | 3 | 0 | 0 |
| Totals | – | 46 | 0 | 2 | 21 | 22 | 1 |
| **Percentages** | **–** | **100** | **0** | **4** | **46** | **48** | **2** |

Male NZ sea lions, like females, were more attracted to the artificial decoys than to the taxidermied decoy. However, most males approached the decoys from the beach rather than from the water. The percentage of males that went to sniff the decoys when walking within the 5 m radius indicated that males checked out the taxidermied decoy in the same way as they did the artificial decoys. Sixty-two per cent of adult males and 67% of sub-adult males that entered the 5 m radius of the taxidermied decoy went to sniff it. Sixty per cent of adult and 66% of subadult males went to sniff the group of three artificial decoys, and 42% of adult and 71% of subadult males went to sniff the lone artificial decoy. While males were only observed to sniff the artificial females in any area of the body, they seemed to exhibit behaviours towards the taxidermied decoy that were similar to those that they exhibited towards live females. We noted on several occasions males of both age classes that repeatedly sniffed either the head or the genital area of the taxidermied decoy, nibbled or bit it, pushed it and rested by its side or rested with their head on its neck or back. None of these behaviours were observed when using the artificial decoys.

While sub-adult males sniffed the artificial females significantly more times than did adult males (Table 4, linear regression model, d.f. = 1, $t = 2.30$, $P = 0.024$), we did not observe this difference with the taxidermied decoy (d.f. = 1, $t = 1.08$, $P = 0.281$). There was no difference between the results of using one or three artificial decoys (d.f. = 1, $t = 0.92$, $P = 0.048$) whereas the number of times that males sniffed artificial and taxidermied decoys significantly differed (d.f. = 1, $t = 4.86$, $P < 0.001$). On average, males sniffed the taxidermied decoy more times than they sniffed the artificial decoys. Males of all ages sniffed the taxidermied decoy on average 4.9 times, while the artificial decoys were only sniffed on average 1.7 times by adults and 2.1 times by sub-adult males.

**Table 3** Number of female New Zealand sea lions coming ashore during 4-hour periods within the different zones during the deployment of a lone taxidermied female decoy at Sandy Bay, Enderby Island, Auckland Islands. Zone B and with Zone with decoys were the shorelines 30 m on each side of the edges of the breeding aggregation. Zone B was the control zone without decoys, Zone with decoys was the experimental zone where the decoys were deployed. Zone A was the rest of the beach on the side of Zone B opposite to the breeding aggregation; Zone C, the rest of the beach on the side of the Zone with decoys opposite to the breeding aggregation. Both Zones A and C were the shorelines that started 30 m from the edges of the breeding aggregation until the end of the beach on each side.

| | | Number of females coming ashore in | | | | | |
|---|---|---|---|---|---|---|---|
| Date | Breeding aggregation (number of females) | Total | Zone A | Zone B | Zone with breeding aggregation | Zone with decoy | Zone C |
| 9 Dec 2007 | 15 | 1 | 0 | 0 | 1 | 0 | 0 |
| 11 Dec 2007 | 28 | 6 | 0 | 0 | 3 | 3 | 0 |
| 12 Dec 2007 | 32 | 4 | 0 | 0 | 4 | 0 | 0 |
| 13 Dec 2007 | 47 | 3 | 0 | 0 | 1 | 1 | 1 |
| 14 Dec 2007 | 55 | 2 | 0 | 0 | 1 | 1 | 0 |
| 16 Dec 2007 | 69 | 3 | 0 | 0 | 2 | 1 | 0 |
| 17 Dec 2007 | 109 | 4 | 0 | 0 | 4 | 0 | 0 |
| 18 Dec 2007 | 90 | 3 | 0 | 1 | 2 | 0 | 0 |
| 20 Dec 2007 | 125 | 3 | 0 | 0 | 3 | 0 | 0 |
| 22 Dec 2007 | 192 | 10 | 0 | 0 | 9 | 1 | 0 |
| 26 Dec 2007 | 210 | 7 | 0 | 0 | 0 | 0 | 0 |
| Totals | – | 46 | 0 | 1 | 30 | 7 | 1 |
| **Percentages** | **–** | **100** | **0** | **2** | **65** | **15** | **2** |

## Discussion

Female sea lion decoys made of white fabric were found to attract female NZ sea lions, whether arrayed singly or in groups. The lone taxidermied female did not attract females, whereas the lone artificial decoy did. This suggests that colour is a significant part of the search image of female NZ sea lions looking for a breeding group to join when they are coming ashore. They searched for and approached the lightest coloured entities on the beach. This result is not surprising as, under natural conditions on the beach, lightest objects represent other females, i.e. safety. The main artefacts that can be found on the beach are seaweeds or rocks (both of dark coloration). Zones A, B and C received only a few visits from females confirming that dark entities on the beach (males, seaweeds, or rocks) did not attract females. All these results support our hypothesis that colour is a significant element of the search image of female coming onshore.

The search image exhibited by female NZ sea lions at the start of the breeding season seemed to fade or change after the females had been at the breeding aggregation for a few days. We hypothesise that most females recognised where the breeding aggregation was from other clues (e.g. topography) once they had previously been there. Most females stopped looking from shallow waters before coming ashore, and ran directly to the breeding aggregation once they had been there at least once.

While female NZ sea lions appeared to be looking for other females when deciding where to come ashore at the breeding beach, they may also look for the quietest area with females. Males' aggression causes the females to move about, and disturbs them throughout the breeding aggregation (Marlow 1975). As a result, females might also prefer to come ashore in the area where females seem the least disturbed (i.e. to join resting animals or decoys). Being deployed outside the breeding aggregation, the decoys were generally in a much quieter area, with fewer movements and male fights. This may also explain the attraction that the decoys had. Nevertheless, we

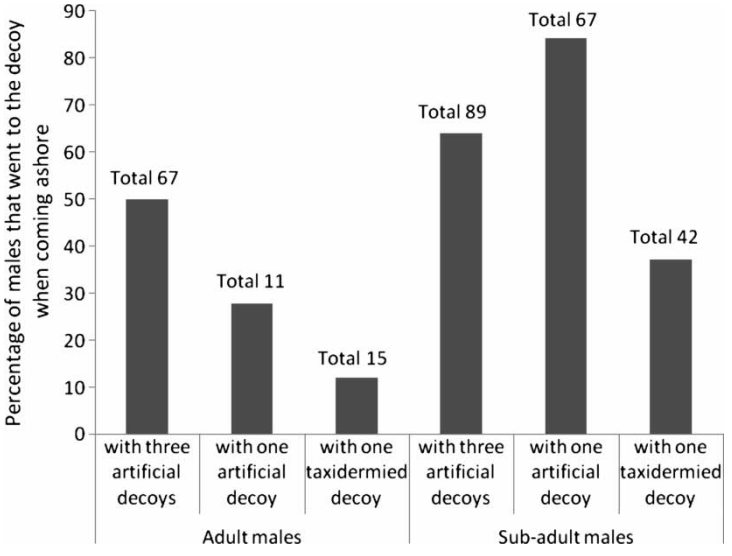


**Fig. 5** Percentage of adult and sub-adult New Zealand sea lion males that went to the female decoys when coming ashore in the Zone with decoys at Sandy Bay, Enderby Island. 'Total' indicates the number of males that were observed coming ashore during all years.

observed females coming ashore in the Zone with decoys during times when all animals in the breeding aggregation were resting. We also witnessed females coming ashore in the Zone with the breeding aggregation when there was a rumble or major fight in progress (i.e. when all animals are sitting up or moving, males are fighting and mothers and pups are calling).

This investigation of the behavioural responses of male NZ sea lions to the decoys highlighted the critical difference between males and females' social behaviours at the breeding beach. While female NZ sea lions benefit from a sharp search image, as they risk injury or death if they do not reach other females (Chilvers et al. 2005), males, especially sub-adult males, have more freedom to investigate the beach. Many more sub-adult than adult males went to investigate the decoys. We suggest this is because adult males' movements were more constrained by competition with other adult males on the beach.

We could have placed the decoys farther away from the breeding aggregation or at another beach. However, if a female comes ashore alone, she may be harassed, injured, or killed by males (Chilvers et al. 2005). For this reason, we chose to work near the breeding aggregation so that females attracted to the decoys had a good chance of reaching the safety of the breeding aggregation no more than 30 m away along the beach.

**Table 4** Mean number of times male New Zealand sea lions sniffed the decoys deployed on the breeding beach at Sandy Bay, Enderby Island.

| | One artificial decoy | | Three artificial decoys | | One taxidermied decoy | |
|---|---|---|---|---|---|---|
| | Adult (n = 23) | Sub-adult (n = 49) | Adult (n = 21) | Sub-adult (n = 74) | Adult (n = 31) | Sub-adult (n = 56) |
| Mean | 1.5 | 1.9 | 1.4 | 2.2 | 5.5 | 4.2 |
| SE | 0.8 | 0.9 | 0.6 | 1.6 | 6.5 | 4.9 |
| Max | 3 | 5 | 3 | 9 | 28 | 27 |

For logistical reasons, we were not able to deploy the decoys before the first females landed on the breeding beach each season. However, for the same safety reasons as listed above, we will not try to do that at Sandy Bay, where the density of males is very high and risk of a lone female being caught and injured is acute. There is no way to predict which females will be the ones to land first and start the breeding aggregation each year, so we cannot know if they will be the oldest females that know the breeding beach or young females that have not learnt how to avoid male harassment efficiently yet. The recolonisation of the New Zealand mainland may still allow the investigation of these questions, and decoys could help.

We conclude that decoys can attract female NZ sea lions, at least when deployed close to an existing group of females, and that this technique has a potential for the management of the recolonisation process of the NZ sea lion onto the New Zealand mainland. At the Otago Peninsula, where the natural recolonisation by breeding females has started, there is the possibility to trial the use of decoy female sea lions to direct the immigrating sea lions to suitable beaches for their protection and to minimize potential interactions with humans. Some beaches have been identified as potentially suitable (Augé 2006). The technique of using decoys to initiate breeding colonies has already been successful with seabirds such as albatross (Podolsky 1990).

Many pinniped species have been reported as sensitive to human activities. Mediterranean monk seals, *Monachus monachus*, Hawaiian monk seals, *Monachus schauinslandi*, and Australian sea lions, *Neophoca cirenea*, are all affected by various levels of human activities at some of their breeding and resting sites (Gerrodette and Gilmartin 1990; Panou et al. 1993; Chandra et al. 2008). All these threatened pinniped species have only small remnant populations recovering from previous human extirpation (exploitation, habitat destruction, and human disturbance). Like the New Zealand sea lion, they could benefit from the use of decoys.

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