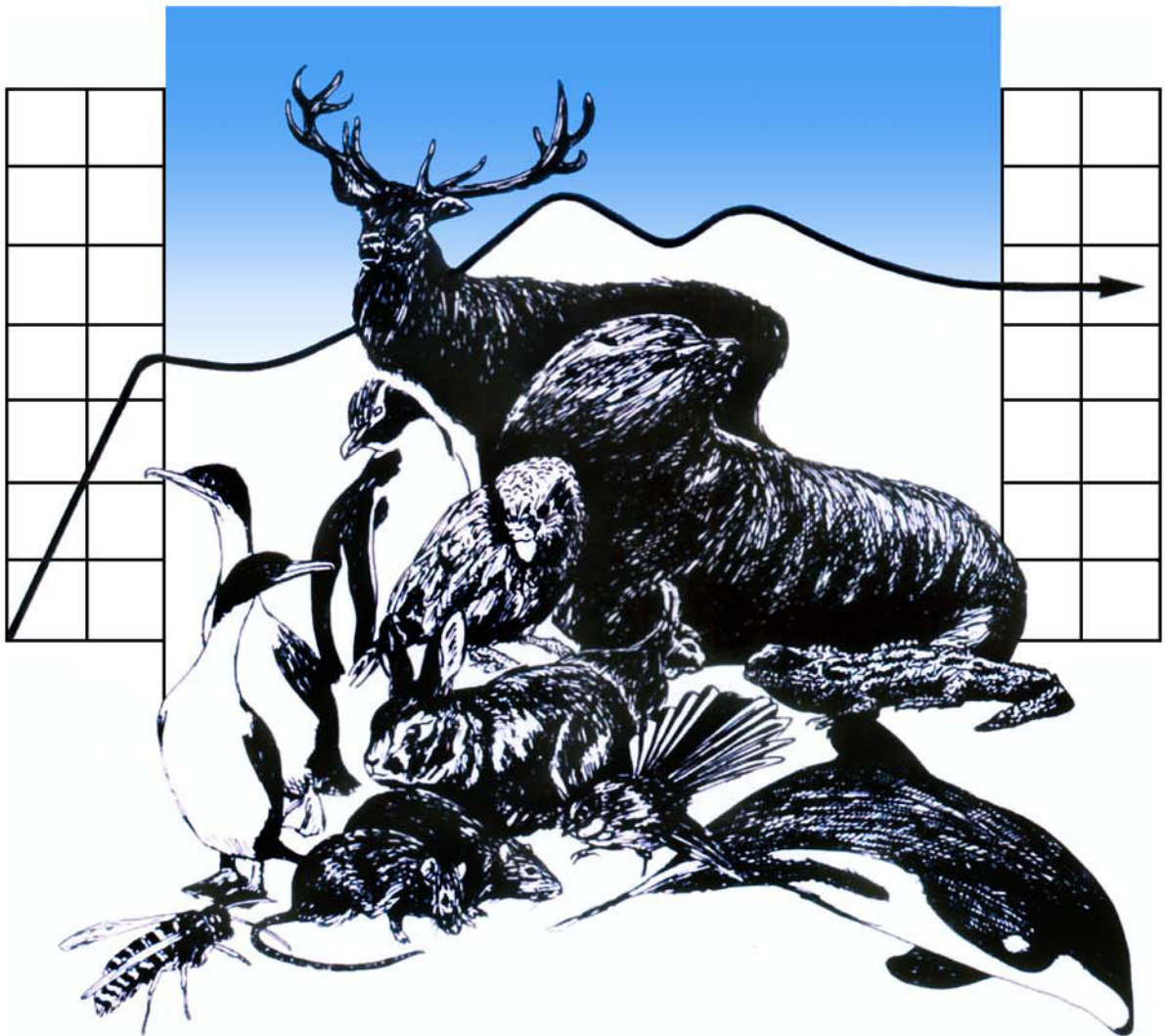




DEPARTMENT OF ZOOLOGY



WILDLIFE MANAGEMENT

**Can New Zealand Sea Lions
(Phocarctos hookeri) be coaxed
away from a populated
beach-side campground using
decoys?**

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Can New Zealand Sea Lions (*Phocarctos hookeri*) be coaxed away from a populated beach-side campground using decoys?



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Abstract

Pinniped populations recovering from historical depletion frequently recolonize habitat in their former range, of which has since experienced human population growth and increased anthropogenic activity and development as a result. Hooker's sea lion (*Phocarctos hookeri*) is slowly returning to a number of sites on offshore islands and the south of the New Zealand mainland. As a result, sea lion-human interactions are more frequent, and of concern to the public and the recovery of the *P. hookeri*.

Phocarctos hookeri have been hauling out repeatedly in the Catlins region of the South Island of New Zealand since 1984. However, since sea lions were last present here in great numbers, the region has grown in human habitation and industry; but perhaps most significantly, is the swell in the number of tourists to the area. Over the height of summer and the Christmas holiday season, an influx of visitors fills the campground at Curio Bay, and Porpoise Bay beach becomes a hive of activity, both human (walking, running, sunbathing, water sports) and wildlife, including *P. hookeri*.

This study aimed to test if adverse interactions between *Phocarctos hookeri* and humans could be minimised by using decoys to attract the sea lions away from the most populated area of the beach. Decoys were placed on Porpoise Bay beach in the Catlins during summer (Dec 2010 - Jan 2011). The decoy was approached by a sea lion on one occasion. The event lasted four minutes, during which the sea lion sniffed and aggressively-defended the decoy. Although results are inconclusive on the effectiveness of decoys, the study provided valuable information about the spatial and temporal variation in sea lion activity on Porpoise Bay beach and adjacent sites over a two month period. The beach was primarily frequented by a small number of non-breeding individuals; mostly sub-adult and juvenile males. At least two adult females, one of which was believed to be pregnant, and three adult males were sighted during the study. The adult males all hauled-out on the far end of the beach on the same day, and their brandings suggest they originated in the Auckland Islands. This study highlighted the necessity for research into sea lion behaviour and haul-out sites establishing on the mainland to manage issues arising from human-sea lion interactions.

Introduction

New Zealand's only endemic Pinniped, Hooker's Sea lion (*Phocarctos hookeri* (Grey, 1844) family: Otariidae (Suisted & Neale, 2004)), was once widely distributed along the coast (primarily the east coast) of the three mainland islands, and as far north as Houhora, 50km south of North Cape (King, 1995). By the late 1800's commercial hunting and Maori subsistence had effectively exterminated the species from the mainland (Gales and Fletcher, 1999). However, the remnants of the population survived at the southerly limit of their range, at the Sub-Antarctic Islands of New Zealand. The Auckland Islands (50°30'S, 166°17'E) are an isolated cluster of islands in the Southern ocean, and hold the last remaining breeding stronghold of *P. hookeri*. Population estimates have fluctuated between 10,000 to 15,000 individuals over the last decade (Suisted & Neale, 2004; Gales & Fletcher, 1999; Gales, 1995), yet most recent estimates are <10,000 mature individuals (Gales, 2008). However population estimates should be acknowledged with caution, as most estimates were derived from counts of pups over a limited number of breeding seasons. Population models are thought to over-estimate abundance as a result of assuming, unrealistic or unknown parameters.

Phocarctos hookeri is classified as 'Nationally Critical' under the New Zealand threat classification system, and is ranked globally 'Vulnerable', with local populations already listed as 'Endangered' by the IUCN (Gales, 2008). The low number of breeding sites and a limited range are the primary reasons for their concerning conservation status (Chilvers & Wilkinson, 2008). The only way to estimate the former abundance or distribution of *P. hookeri* is by using historical accounts and fossilized skeletal remains (King, 1995; Walker & Ling, 1981). Most similar Otariid species are significantly more abundant than *P. hookeri* (Chilvers et al., 2005; Gales & Fletcher, 1999). The New Zealand Department of Conservation 2005-2010 Recovery Plan for *Phocarctos hookeri*, states that "the establishment of new breeding locations at areas other than the current subantarctic breeding range is a priority for the species" (Suisted & Neale, 2004).

Although *Phocarctos hookeri* has a restricted breeding range, individual 'migrant' sea lions have been hauling out on other offshore islands and various southerly locations on the New Zealand mainland for some time (Lalas, 2008). These migrants are most commonly juveniles, sub-adult males, and other non-breeding sea lions. The only breeding to occur away from the Auckland and Campbell Islands in the last 100 years has been on The Snares and Stewart Islands, and Otago Peninsula on the New Zealand mainland (McConkey et al, 2002; Marlow & King, 1974). Sea lions have also been known to frequent Macquarie Island and other Sub-Antarctic Islands, and there are additional accounts of sea lions hauling out on shores of the southern South Island, including multiple sites in the Catlins region and other sites south of Banks Peninsula. Migrant male *P. hookeri* have recorded hauling-out on the Otago Peninsula since the mid 1980's, and there has been an annual increase in the number of resident male and female *P. hookeri* of approx. 10% and 13% respectively (Lalas, 2008). The Otago Peninsula is also the site of the first record of a Hooker's sea lion born on the mainland since the last of the historic mainland colonies were abolished in the 1830's.

Otariid females are generally non-migratory (with the exception of northern fur seals, *Callorhinus ursinus*) (Oftedal et al., 1987). However, a single adult female Hooker's Sea lion from the Auckland Islands first gave birth to a pup on the Otago Peninsula in 1993. The female and her progeny have

been returning to the mainland to breed ever since, and the peninsula has seen the birth of at least 40 sea lion pups (Auge & Chilvers, 2010). However, the female *P. hookeri* at Otago remain “solitary, non-colonial breeders outside the usual harem situation” of the subantarctic rookeries (McConkey et al., 2002).

Following depletive harvest, a number of Otariid populations have shown signs of recovery, including; population growth, expansion of range and an increase in the number of breeding colonies (Grandi et al., 2008; Marlow and King, 1974). Such progresses are crucial requirements for the persistence of *Phocarctos hookeri* populations and the longevity for species (Chilvers & Wilkinson, 2008). Population growth is often facilitated by protective legislation, establishment of reserves, habitat improvement, and increases in food resources (Lalas & Bradshaw, 2003). Although, such initiatives should be modelled around the ‘best available information’, and more importantly, management plans should be updated when more accurate information becomes available. For example, the Auckland Islands are

With small but significant reports of *Phocarctos hookeri* hauling-out and breeding on the mainland, there is potential for greater re-colonization of its previous range, and establishment of new breeding sites. However, the mainland has been drastically altered by human presence since the species was last abundant on its shores. Expanding anthropogenic utilization and alteration of the coast bring additional challenges to the recovery of the species.

The increasing frequency of sea lion haul-outs on the mainland, means increased potential for human-sea lion interactions. Ship-strike poses a common threat to marine mammals, and vehicle collisions with Pinnipeds are becoming of greater concern worldwide, as species recolonize areas in contact with sprawling human populations. Numerous accounts exist of New Zealand fur seals (*Arctocephalus foresti*) being struck and killed by road and train traffic (Boren et al., 2007). Not only are accidental anthropogenic-induced mortalities of Pinnipeds a concern, but more so, are those which are intentional. On December 10th 2010, 23 New Zealand fur seals were clubbed to death near Kaikoura at a colony frequented by tourists (Wildlife Extra, 2010). Between 1994-95, six *P. hookeri* of a population of ~20 were reportedly killed in the Catlins by humans (Childerhouse & Gales, 1998). These examples of pinniped culling highlight an immediate caution with the return of *Phocarctos hookeri* to the mainland: what are the potential levels of human interaction with the species, and how will this affect sea lion survival/recovery? Additionally, how can we solve the potential problems such interactions may incur without compromising re-colonization success?

To encourage re-colonization of previously occupied distributions by *Phocarctos hookeri* and other Otariids, threats and anthropogenic disturbance at potential breeding and haul-out sites should be mitigated. Translocations will likely prove frivolous for pinnipeds, as most species show a high level of site fidelity and/or philopatry (Chilvers & Wilkinson, 2008). ‘Aided’, rather than ‘enforced’ relocation may have a greater success rate for achieving more permanent relocations. The use of decoys to encourage sea lions to haul-out at a certain site has been successfully demonstrated with *P. hookeri*. Auge and Chilvers (2010) successfully used artificial and taxidermy sea lions as decoys to attract female *P. hookeri* onto a breeding beach on Enderby Island (at north end of the Auckland Islands cluster) over three consecutive breeding seasons (2006-08). Such management tools could enable conservationists to encourage sea lions and potentially other Otariids to haul-out on beaches with less anthropogenic disturbance. Thereby, giving some control to managers in facilitating,

encouraging and mediating the establishment of pinniped populations on human-inhabited coastlines.

For management techniques to be successful, they should be justified by sound information. Raum-Suryan et al. (2004) rightly state that “knowledge of pinniped behaviour ultimately leads to information regarding survival and its affect on the population growth of the species.” Thereby, behavioural studies of *P. hookeri* visiting or resident to the mainland should be conducted to provide insight into the apparent and potential effects of sea lion-human interactions, and how problems can be mitigated whilst facilitating sea lion re-colonization to mainland New Zealand. Swumway (1999) stated that behavioural information is invaluable to five areas of conservation; ¹. managing wild species, ². reversing adverse effects leading to population decline, ³. assessing biodiversity. ⁴. captive breeding and reintroduction programs, and ⁵. changing human behaviour in resource exploitation. Shaumway’s last point should be expanded to include changes in human behaviour and attitudes towards species they interact with, and the conservation measures in place to protect them.

The Catlins region at the south of New Zealand’s South Island has been occupied by *Phocarctos hookeri* continuously since 1984, and the estimated population size of immigrant sea lions in the region has shown slow, but steady increases; from 40 males and two females in 1994, to 108 males and three females in 1999 (McConkey et al., 2002).

This study aimed to determine whether or not adolescent *Phocarctos hookeri* can be attracted away from a popular campsite, and moved to the less populated end of the beach. A number of aims were formulated to test the effectiveness of using decoys for attracting *P. hookeri* away from undesired (human-populated) areas.

- Determine sea lion use of the beach and campground, and how this may change across the day.
 - Are individual sea lions frequenting the same locations?
 - Is this sex/age dependant?
 - Does sea lion activity vary across the day?
 - Does sea lion activity correlate with weather conditions?
- Determine if *P. hookeri* are attracted to decoys on Porpoise Bay beach.
 - Does human disturbance affect their haul-out behaviour?
 - Does the effectiveness of the decoy vary according to age and/or sex of the sea lions?
 - Can decoys be used to encourage the sea lions to haul-out further along the beach?
 - Will changes to sea lion haul-out sites be permanent if the decoys are able to move the sea lions to the less-populated end of the beach?

The above aims were addressed using; 1. Spatial surveys to determine sea lion use of Porpoise Bay beach and Curio Bay Campground during the day, and 2. Decoy trials; 3x 2hr observation periods to test decoy attractiveness to sea lions over different times of the day.

Methods

Study Site

Sea lion observations were conducted at Curio Bay in The Catlins, New Zealand. Spatial surveys and decoy trials were conducted in summer between 7th December 2010 and 19th January 2011 on Porpoise Bay beach and in the adjacent campground (fig. 1). Porpoise Bay beach is backed by beachfront accommodation and private housing from the campground at the headland to ~250m beyond the creek which intercepts the beach. The remainder of 4,400m long sandy beach is backed by tussock-covered dunes, where it is terminated at the north end by the estuarine entrance to Waikawa Harbour. Vehicle access to the beach is limited to a 4WD track near the creek. Most human traffic on the beach occurs between the campground and the beachfront properties.

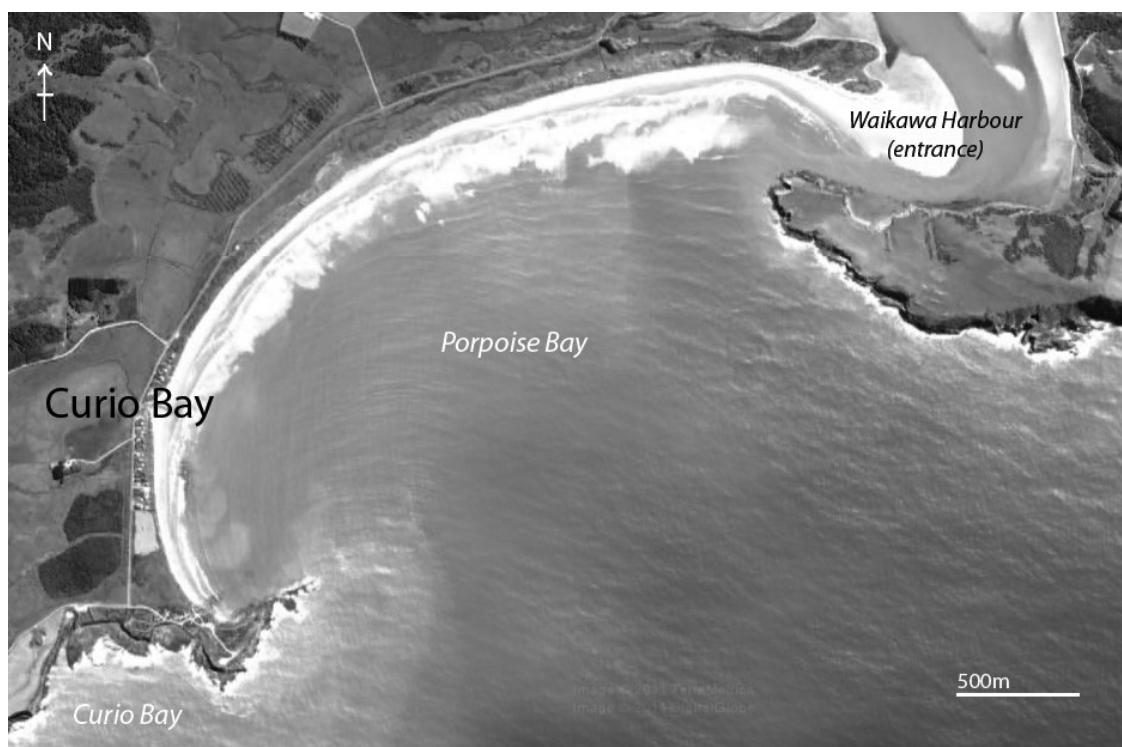


FIGURE 1. Aerial photograph of Curio Bay. Adapted from Google Earth, 2011.

Spatial Surveys

Spatial surveys of *Phocarctos hookeri* were conducted throughout the study to gain information on sea lion occupancy of the campground and beach during the day. Surveys were conducted at hourly intervals between 07:45 and 20:45 hrs. Binoculars, a camera and a hand-held GPS were used to record information about each sighting. Surveys focused on southern end of the beach and campground, as these areas are subject to frequent sea lion/human interactions. Information about sea lions observed in the area was recorded, including; sex/age group (fig. 2), movements, behaviour and identification. Photos were taken for identification purposes as some sea lions in the area (including Waipapa Point) have been bleach marked (Robertson et al., 2006), and others from the Auckland Islands may also be branded or tagged (Chilvers & MacKenzie, 2010).

Age/sex classes are commonly used to group demographics in Pinniped species (Walker & Ling, 1981). Classes are often characterised by differences in; social behaviour, activity and most obviously physical appearance. This study classified sea lions using the following morphological traits: Both male and female Juvenile *Phocarctos hookeri* are small, and resemble females in colouration for the first year, after which the males darken (King, 1995). Females become adults (sexually mature) at three years old and first reproduce at four (Gales & Fletcher, 1999; King, 1995). Adult females do not develop a mane and are notably smaller than adult males (sexual dimorphism) (max. weight: ~230kg, max. age: 18), with a light, creamy coloured coat, and a darker muzzle and flippers. Sub-adult males are similar in size to adult females, their coats vary from black to brown, and they develop manes and a thicker neck as they age. Adult males can weigh more than 400kg, with a large, robust head, and the bulk of their weight suspended by their front quarters. They have a dark brown to black coat, and a thick black mane reaching the shoulders, growing in length with maturity (max weight: 450kg, max. age: 23). Males sexually mature at five years, however they do not socially mature until they are eight (Reeves, 2002; Gales and Fletcher, 1999; King; 1995; Walker & Ling, 1981). Unidentifiable sea lions were either swimming or only seen from a distance.

Classifying sea lions accordingly gives an idea on social composition and habitat preferences of *Phocarctos hookeri* either resident or visitors to Curio Bay and the Catlins Region (Grandi et al., 2008; Bodin et al, 2000). In this study, sea lions observed were recorded as one of five age/sex classes; Juvenile (JM)*, Sub-adult-male (SAM), Adult female (AF), Adult male (AM), and those which were unidentified (UNID) (often because they were swimming or moving) (fig. 2).



FIGURE 2. Morphological characteristics of age/sex classes of *Phocarctos hookeri* observed in Curio Bay, Dec-Jan (2010-11). a. Juvenile male (JM)* - young male (moulting); b. adult female (AF); c. sub-adult male (SAM); d. adult male (AM); e. unidentified sea lions (UNID).

*The 'Juvenile' age class was later changed to 'Juvenile male', as no juvenile female *Phocarctos hookeri* were observed in the area over the duration of the study.

Decoy Trials

A collection of five artificial (life-sized, stuffed canvas sea lions) and one taxidermy female *Phocarctos hookeri* were deployed on the beach in various combinations for two hour observation periods for 25 days (fig. 3). Trials were conducted three times per day (as conditions permitted), at spaced, two-hourly intervals (08:30-10:30, 12:30-14:30, 16:30-18:30) to allow for identification of possible diurnal fluctuations in sea lion activity (Miller, 1991).



FIGURE 3. Sea lion decoys on Porpoise Bay beach. A. Taxidermy adult female *Phocarctos hookeri*. B. Taxidermy decoy (right) and two artificial decoys; one adult female and one sub-adult male (left). C. DOC staff with decoys on beach; one adult male and three adult female decoys (incl. the taxidermy female).

The two artificial females were constructed of white fabric which had been soiled to remove their starkness, whilst the three representative males were dark brown to mimic the differences in colouration between the sexes of *Phocarctos hookeri*. Two of the males were made the approximate size of a sub-adult male (approximately the same size as an adult female), and the third male was made larger with a thicker neck as is characteristic of mature adult males/alpha males (Reeves, 2002; Gales and Fletcher, 1999). Initially, we intended to compare the effects of different group sizes, sex ratio and spacing on their behavioural effect on sea lions. However, a low sample size and a limited number of positive results spurred the addition of extra decoys to the trial group, with the hope of generating more results by increasing decoy visibility. Decoy group composition also varied with conditions, for example the taxidermy female could not be left out in the rain.

Decoys were placed on the beach at the start of each observation period, and removed at the end. Decoys were either carried onto the beach or driven on with a 4WD utility vehicle (depending on the number and weight of the decoys). If a vehicle was used, it was parked at least 100m from the decoys during a trial as to disassociate the vehicle (and human activity) from the decoys to control for its possible effect on sea lion behaviour. However, vehicles are a common site on Porpoise Bay

beach, and it is not uncommon for a sea lion to be lying within 10m of a vehicle or person(s) (personal obs.)(fig. 4).



FIGURE 4. An adult female *Phocarctos hookeri* comfortably resting next to cars, buildings, tents and people at Curio Bay campground, the Catlins.

When the decoys were deployed, sand was lightly tossed over them to imitate the “flipping” behaviour (flicking sand onto their back with their flippers) displayed by sea lions to regulate their body temperature (Walker & Ling, 1981) (fig. 5). Additionally, the sand made the single-toned colours of the canvas decoy appear more like the naturally mottled and uneven coat of sea lions undergoing a moult*(fig. 6).

*Adult *Phocarctos hookeri* moult during March and April, juveniles may moult slightly earlier (Reeves et al., 2002).



FIGURE 5. Sub-adult male *Phocarctos hookeri* flicking sand over himself on Porpoise Bay. The furrows in the sand next to the sea lion (a) are the result of sand flicking behaviour (b).

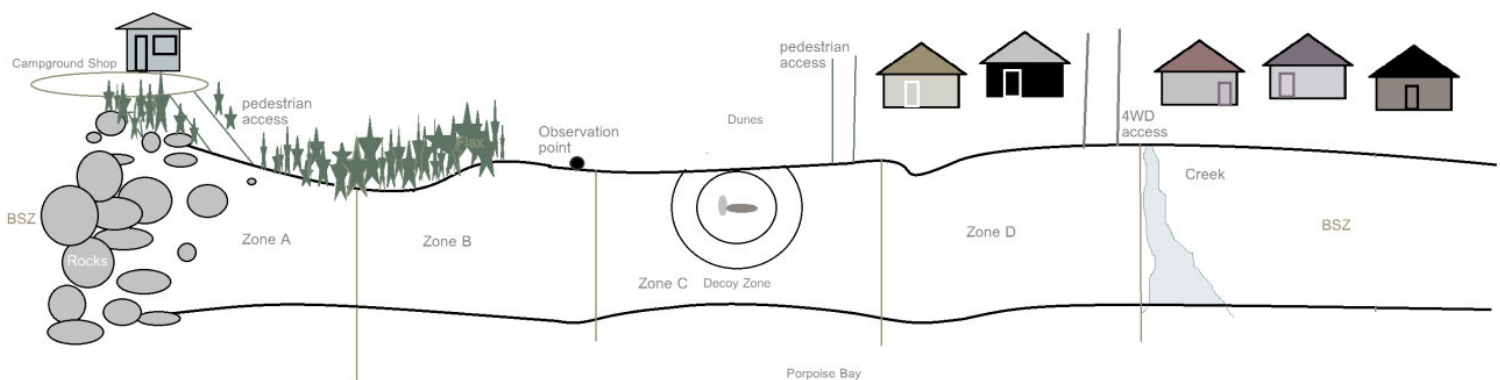


FIGURE 6. Juvenile male *Phocarctos hookeri* with a mottled coat as he moults last year's pelage. The distinctive, hairless patch over his hips provided a natural identification mark.

Decoy location was attained using a GPS (model, brand). Initially, decoys were placed approximately half-way between the campsite store at the southern end of the beach, and the creek (Beach 1)(fig. 7a). However, the human traffic (and curiosity) on the beach became increasingly disruptive to the decoy trials over the holiday season. In a move to minimise these disruptions, decoy trials were moved northwards of the creek, beyond the beachfront properties and the majority of the human traffic (Beach 2) (fig. 7b).

Decoys were positioned on the beach near the high tide line. Circles with radii of five and ten meters from the decoy(s) were drawn in the sand as a measure of proximity to the decoy(s) (Auge & Chilvers, 2010). The study area (Beach 1 or 2) was divided into four zones; Zone A at the south end of the beach, Zone D at the north. In between, Zone C contained the decoys, and the observer was positioned in Zone B, close to the Zone C boarder in the dunes, and concealed by foliage (fig. 7). The observer watched sea lion, human and other obvious activity on the beach, recording; sea lion haul-outs, movement and behaviour, human numbers, whereabouts and activities, and interactions between both. Other information collected for each observation period included weather, tides, wind and swell. Details were obtained for sea lions (*see Spatial Surveys*) within the study area, and those beyond the study area when possible.

a.



b.

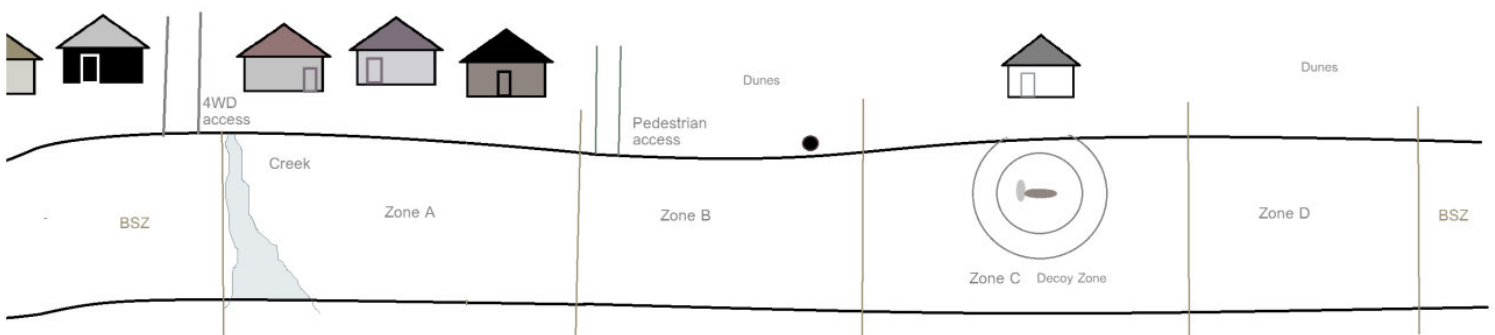


FIGURE 7a,b. study zone for decoy trials on beaches 1 (a) and 2 (b) (Not to scale). Beaches 1&2 are defined by the areas covered from Zones A through to D. BSZ = Beyond the Study Zone.

Photo Identification

A small digital camera was used to take photographs of any *Phocarctos hookeri* observed over the duration of the study. (However, decoy observations required the observer to keep watch on the decoys, therefore sea lions were only photographed if in the study zone during a trial). Photographing individuals allowed confirmation of age/sex class, and identification of marked individuals for the purpose of individual and population dynamics. Previously marked *P. hookeri* at different localities (such as the Auckland Islands) may provide valuable information about immigration rates and residency of *P. hookeri* on the mainland. Marked individuals are sea lions which can be easily identified by a permanent (or semi-permanent) natural or artificial marking(s) (fig. 8).

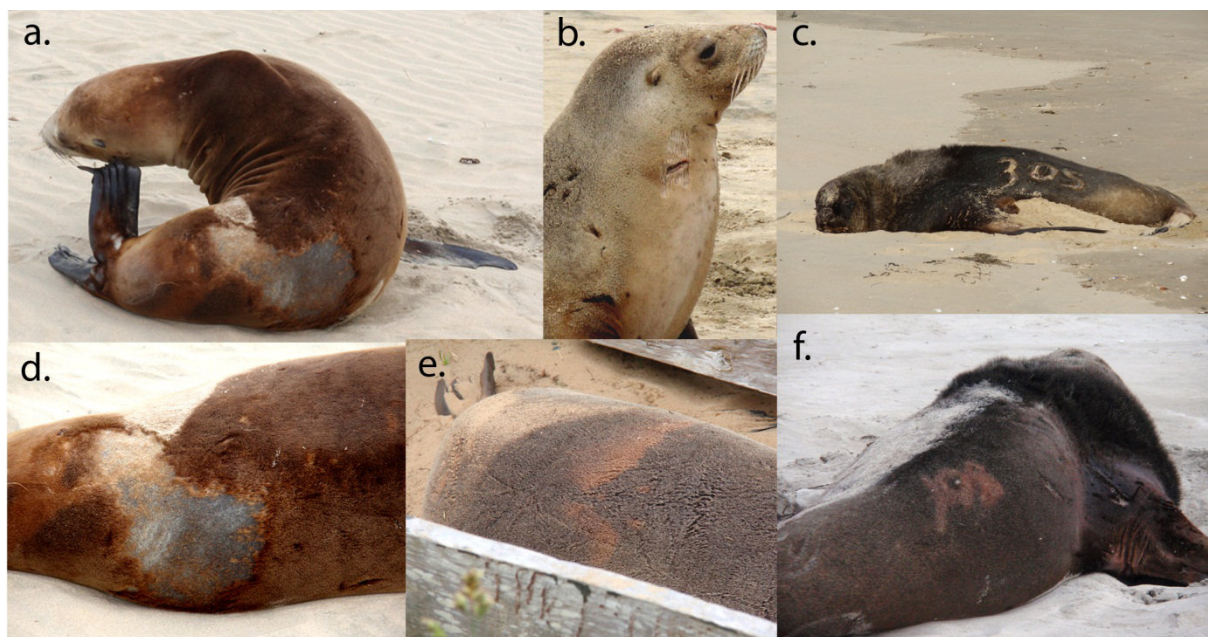


FIGURE 8. *Phocarctos hookeri* identification markings: Natural markings – a & d. juvenile male sea lion with an unusual hairless patch over his hind quarters; b. adult female with distinctive scars on her neck and right shoulder. Other markings used to study *P. hookeri* include bleach markings (e. adult female and f. adult male) and branding (c. adult male).

Results

Spatial Surveys

The majority of *Phocarctos hookeri* to hauled-out in the Curio/Porpoise Bay area (Jan/Dec) were observed on beach 1 (fig. 9 & 10). Juvenile male (JM), sub-adult male (SAM), and adult female (AF) *P. hookeri* hauled-out on Beach 1, however no adult males were observed in this area. Sea lion observations appear clustered into three loosely defined areas on beach 1. The only sea lions which were seen in the campground were SAM and AF *P. hookeri*. SAMs were the only age group observed on the small pebbly beach in Curio Bay. All age classes (except pups –were seen during this study)

were observed along Beach 2. However, sea lions were infrequently observed on Beach 2, and the few observations were thinly distributed along the beach. Adult males however ($n = 3$), and one sea lion of unidentified sex, were the only *P. hookeri* seen at the northern end of Porpoise Bay beach (fig. 9).

Note: Juvenile female *P. hookeri* are not mentioned in the data as none were identified in the area over the duration of the study.

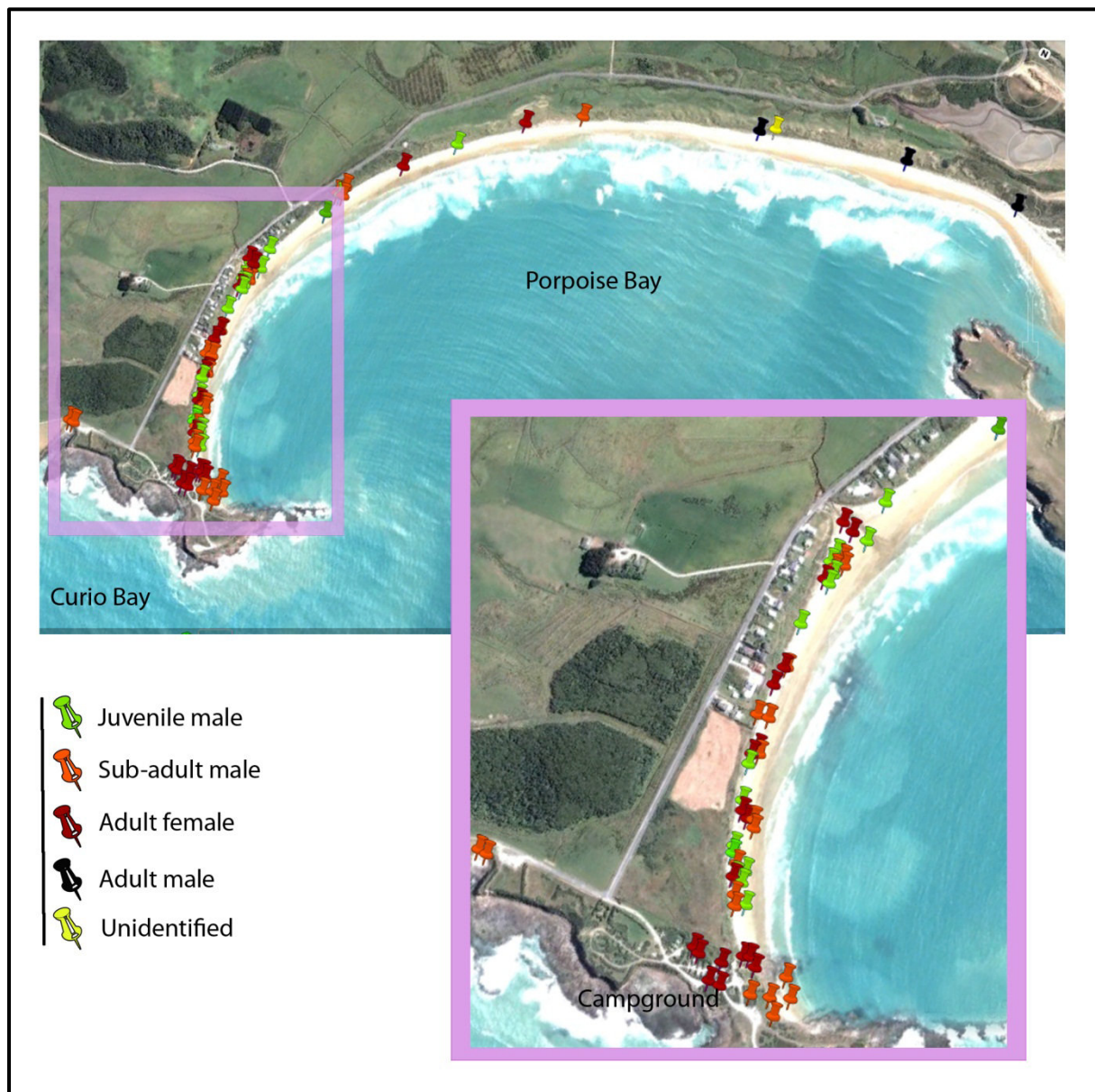


FIGURE 9. Distribution of *P. hookeri* haul-out and resting sites at Curio and Porpoise Bays, New Zealand. Observations made over Dec 2010 – Jan 2011. Pin colour represents sex/age class: Green – Juvenile male; Orange – Sub-adult male; Maroon – Adult female; Black – Adult male; Yellow – Unidentified. Adapted from Google Earth, 2011.

Occupancy

Beach 1

Sub-adult male (SAM) *P. hookeri* were the most frequently observed age/sex class on Beach 1 (fig. 10). The number of days that SAMs were observed on Beach 1 peaks between 2:00pm and 4:00pm (n = 9), with a bell-shaped drop off either side. Additionally, the only observations of more than one sea lion of the same sex/age class were of SAMs on Beach 1. Between Midday and 3:00pm, two SAMs were observed on the same section of beach on one or two days. Juvenile males (JM) were observed on Beach 1 most frequently (up to 5 days) between 8:00am and 8:00pm. Observation frequency diminished just prior to and after this 12hr period.

Adult female (AF) *P. hookeri*, like JMs were sighted on Beach 1 during a large range of times over the day. The hour during which AFs were seen on the beach most frequently (6), was 10:00am – 11:00am. No adult males were not observed on Beach 1.

Beach 2

Most JM and SAM were observed on northerly curve of the beach (Beach 2) between Midday and 2:00pm. However, both age groups were observed on the beach on a small number of occasions throughout the day. AF were seen on Beach 2 once or twice between 4:00pm – 5:00pm. Individual adult males were only seen on three single occasions on the northerly end of the beach 3:00pm – 10:00pm. These adults were all branded (5P, 108 and 305). Another sea lion which could not be identified was seen in the same area between 3:00pm and 6:00pm.

Campground

AFs were observed in the campground on two days between 8:00am and 9:00pm. SAMs were seen in the campground at various intervals across the day. No juvenile or adult males were observed in the campground. Sea lions were seen lying on grass, under flax and moving around the campground via tunnels through the flax bushes which segregate the campsites.

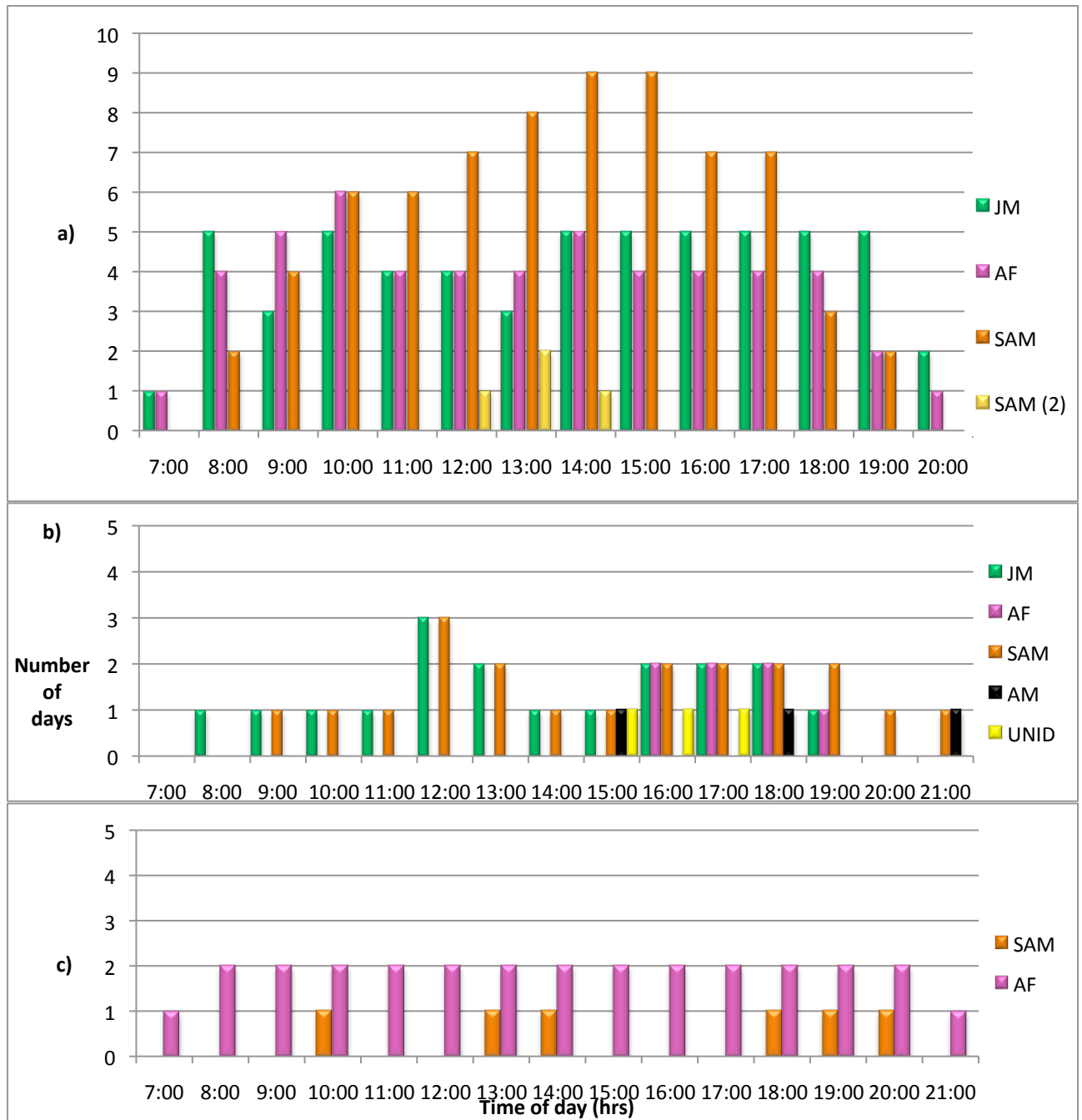


FIGURE 10. The number of *P. hookeri* observed on ^{a)} Beach 1*, ^{b)} Beach 2 and ^{c)} in the campground over Dec-Jan. The ‘number of days’ (y axis) refers to the number of days during which sea lions were seen in one of the three areas over different times of the day. Observations are plotted according to age/sex class: Juv = Juvenile male, SAM = Sub-adult male, AF = Adult female, AM = Adult male, UNID = Unidentified.

*Figure 10a. includes ‘SAM (2)’ – these were the only instances when two sea lions (same age/sex class) were observed in the same area at the same time. Observations are segregated by the hourly period in which the observation took place (e.g. ‘7:00 = sea lion observations made between 7:00am and 7:59am).

Sea lion Diurnal Activity

Juvenile *P. hookeri* were the most common age classes* to haul-out on Porpoise Bay beach during observations over a two-month period in summer (2010 – 11) (table 1).

TABLE 1. Number of sea lions in each age class observed hauling-out onto Porpoise Bay beach over December 2010 – January 2011.

	Juvenile Male	Sub-adult Male	Adult female	Adult male	Unidentified
No. of sea lions	10	7	2	2	5
% of sea lions	38%	27%	8%	8%	19%

Observations show general trend of decreasing *P. hookeri* activity over the day's progression in three age classes – Juvenile, Sub-adult Male (SAM) and Adult Female. Unidentified sea lions were active 100% of the time. Of *P. hookeri* identified, the majority of sea lions from all age classes were inactive on the beach during the day (the lowest observed was 39% of Juveniles in the AM obs. period). Larger proportions of Juvenile and SAMs were active/alert than adult males and females (fig. 11).

* Age classes of *P. hookeri* are characterized by age/size and sex as follows: Juvenile – young sea lion, age, weight/size, light coloured; Sub-adult Male (SAM) – adolescent male, age, weight, small or no mane, light to chocolate brown; Adult female – fully grown female, approx.. same size as SAM, pale brown/cream; Adult male – large male, age, weight, dark brown, thick mane-covered neck (refs).

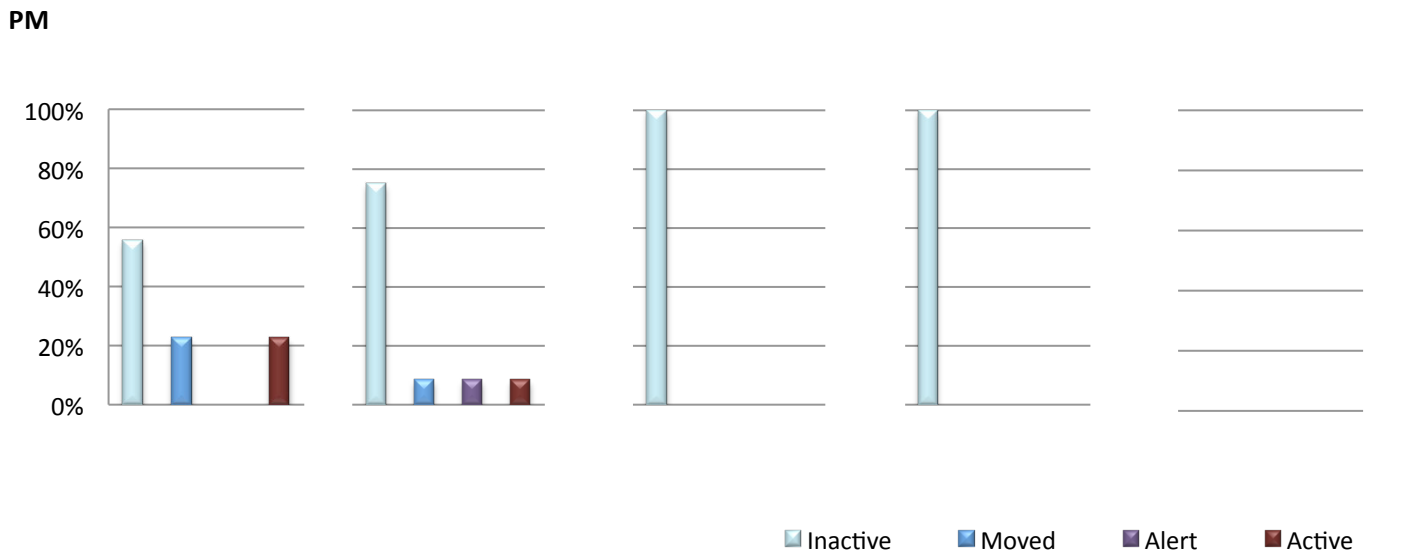
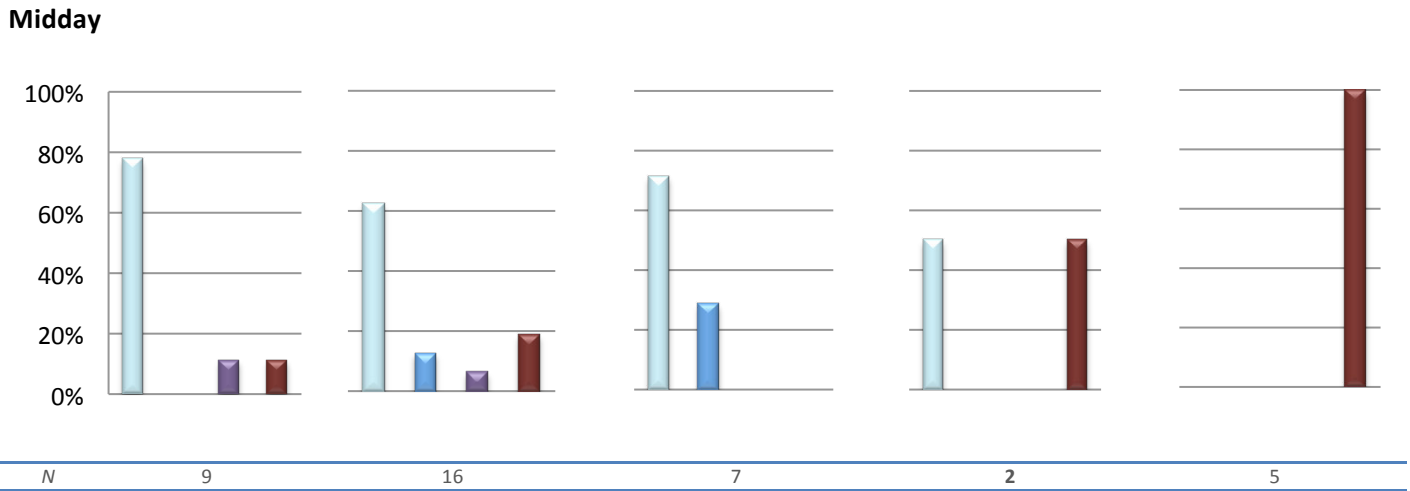
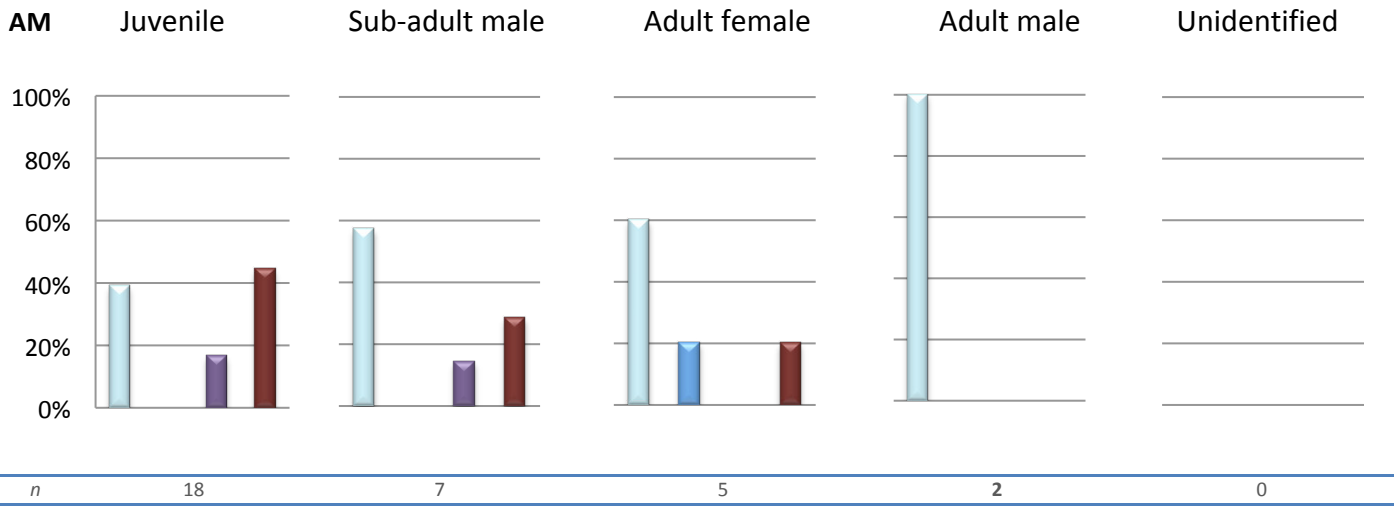


FIGURE 11: The activity levels (inactive, moved, alert, active) of *P. hookeri* over three (three hour) periods throughout the day. Sea lions are divided into age/sex classes (Juvenile, sub-adult male, adult female, adult male and unknown). *N* is the number of sea lions on the beach in a particular state or 'level' of activity.

Decoy Trials

The only definitive event which indicated that decoys attracted sea lions (*Phocarctos hookeri*) on Porpoise Bay beach occurred at 18:06hrs, 11th Dec, 2010. A sub-adult male *P. hookeri* hauled-out on the beach in the decoy zone, and approached the single artificial decoy (stuffed-canvas). The sea lion walked directly up the beach to decoy, sniffed twice it twice, and lay down within five meters of the decoy. People walking along beach tried to get past, however the tide was in, forcing them to try to get past within 15m of the sea lion and decoy. The young male sea lion acted aggressively; roaring and charging at the passers-by twice. Four minutes after the sea lion first hauled-out, it returned to the water and swum away.

Most sea lion ‘haulouts’ occurred within zones A and D (n = 3 per zone). Zone A also experienced the highest number of ‘false haulouts’ (4) and ‘quick haulouts’ (2). The second-highest number of false haulouts occurred in Zone C (Decoy Zone). Haul-ins were observed in all zones but Zone D (fig. 12).

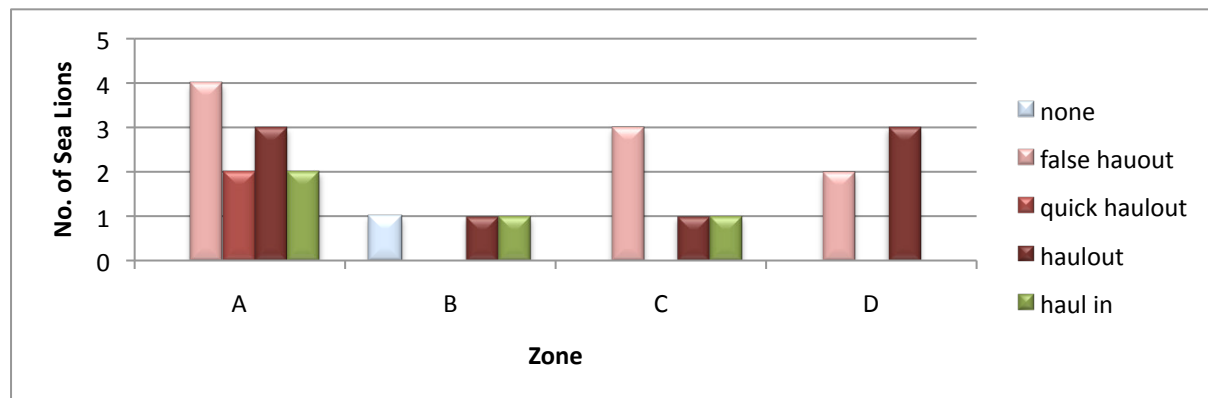


FIGURE 12. The number of sea lions observed to haul out or in (to the water), or swim into the shallows adjacent to the study zones. Haulout categories: ‘None’(N) - No haulout (sea lion kept swimming); ‘False haulout’(FH) - Sea lion stood in shallows, or exited and re-entered the water within one minute; ‘Quick haulout’(QH) – Sea lion re-entered the water within 30mins (and more the one min) from hauling out; ‘Haulout’(H) – Sea lion hauled out of the water, and remained out for more than 30mins; ‘Haul in’(HI) – Sea lion enters the water and swims away.

On average, Zone B contained the most people (22) during a haulout event (n = 1). Zone A contained an average of nine people in the event of a sea lion hauling out (n = 3), and an average of seven in the zone during a false haulout event (n = 4). An equal average number of people were on the beach (three) during false haulouts, haul-ins, and haulouts observed in the Decoy Zone (C). Averages of five and four people were on the beach in Zone D in the event of false haulouts and haulouts respectively (fig. 12).

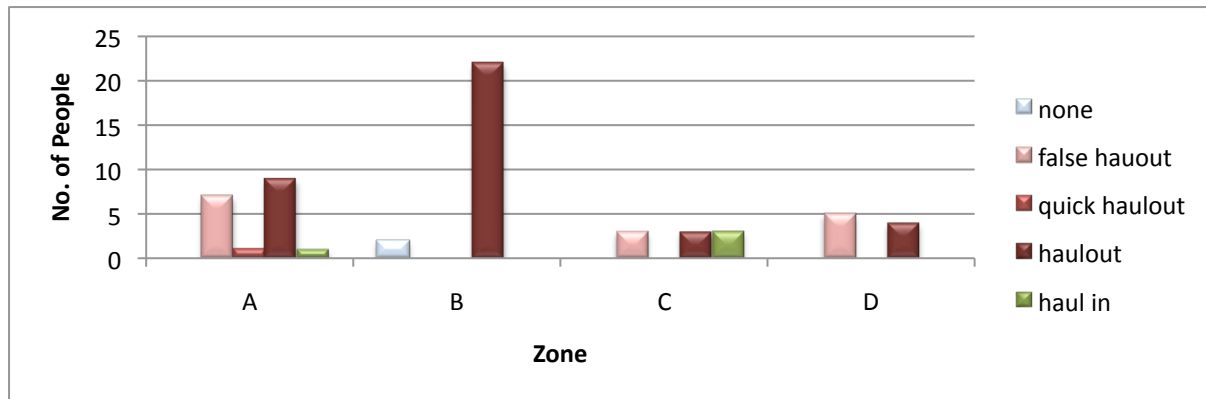


FIGURE 12. The average number of people on the beach at the same time, in the same study zone as a sea lion hauled out. Haulout categories: ‘None’(N) - No haul-out (sea lion kept swimming); ‘False haulout’(FH) - Sea lion stood in shallows, or exited and re-entered the water within one minute; ‘Quick haulout’(QH) – Sea lion re-entered the water within 30mins (and more the one min) from hauling out; ‘Haulout’(H) – Sea lion hauled out of the water, and remained out for more than 30mins; ‘Haul in’(HI) – Sea lion enters the water and swims away.

On average, the greatest number of people present in the same (eight) or adjacent (four) zones as a sea lion, was when it was hauled out completely. False haulouts occurred when an average of five people were present in the same zone as the sea lion. Sea lions did not haul out when an average of two people were in the same zone they approached the shore within. An average of just over one person was present in the same zone as a sea lion when it hauled in. Less than one person on average was present in the same or adjacent zone to a sea lion observed to execute a quick haulout (fig. 13).

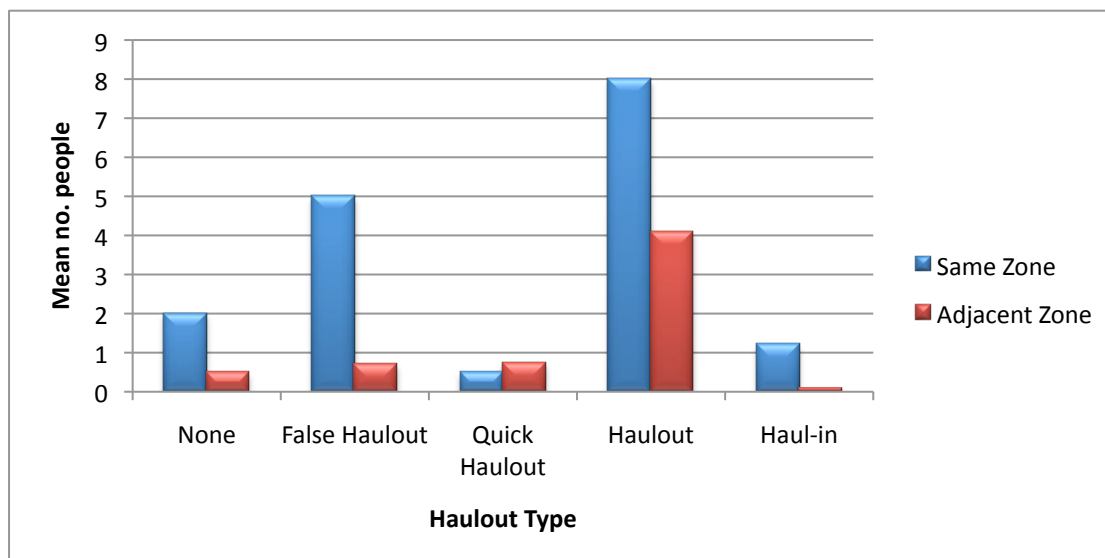


FIGURE 13. The average number of people in the same and adjacent zones as a sea lion as it hauled-out. Haulout categories: ‘None’(N) - No haul-out (sea lion kept swimming); ‘False haulout’(FH) - Sea lion stood in shallows, or exited and re-entered the water within one minute; ‘Quick haulout’(QH) – Sea lion re-entered the water within 30mins (and more the one min) from hauling out; ‘Haulout’(H) – Sea lion hauled out of the water, and remained out for more than 30mins; ‘Haul in’(HI) – Sea lion enters the water and swims away.

The sea lions which were observed to be disturbed before or during a haulout event did not haul out completely. Three false haulouts occurred after sea lions were approached and/or pursued by a person. A single false haulout event occurred when a small juvenile sea lion was chased back to the water by an aggressive sea gull. The remaining haulout events occurred without obvious disturbance to the sea lion during the activity (fig. 14).

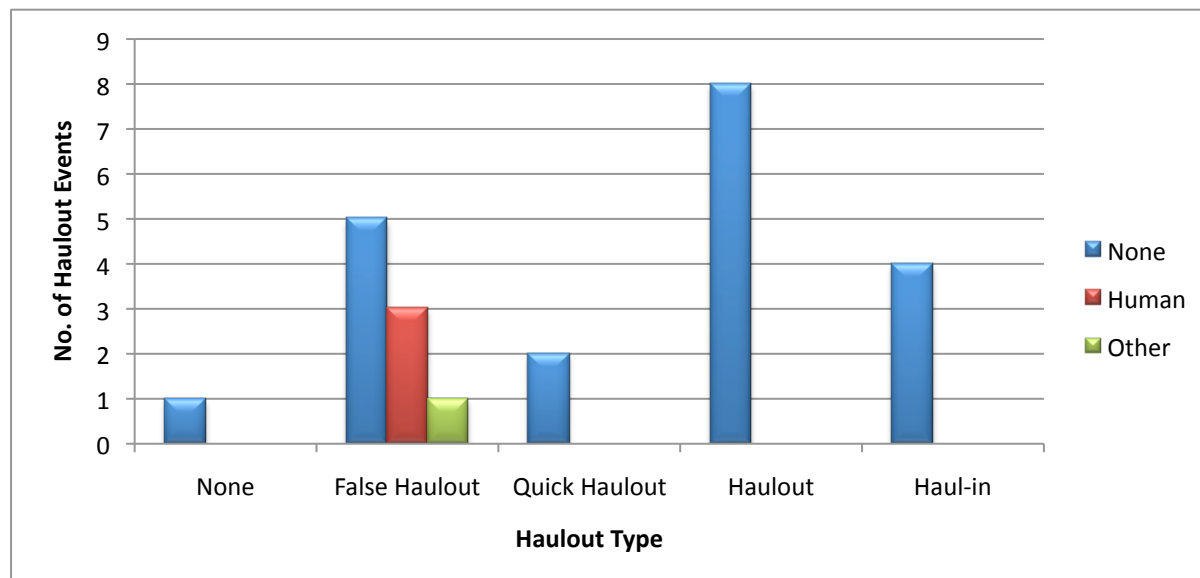


FIGURE 14. The number of haulout events by disturbance. Legend: 'None' - No disturbance; 'Human' – sea lion was approached and/or pursued by one or more people; 'Other' – Another source of disturbance to the sea lion. Haulout categories: 'None'(N) - No haul-out (sea lion kept swimming); 'False haulout'(FH) - Sea lion stood in shallows, or exited and re-entered the water within one minute; 'Quick haulout'(QH) – Sea lion re-entered the water within 30mins (and more the one min) from hauling out; 'Haulout'(H) – Sea lion hauled out of the water, and remained out for more than 30mins; 'Haul in'(HI) – Sea lion enters the water and swims away.

Twelve sea lion haulout events occurred when people were walking in the same zone. Additionally, eight haul-outs occurred when people were in the water adjacent to the study zone on the beach. Seven false-haulouts occurred in the same zone as people were walking in/through. The same number of false-haulouts as haulouts (four) happened when people were either sitting or standing (still) in the same zone as the sea lion. Both haul-outs (three) and haul-ins (one) happened when no people were in the same zone as the sea lion. Complete haul-outs happened during all categories of human activity. False-haulouts only occurred when human activities were occurring in the same zone as the sea lion. Similarly, quick haulouts occurred when people were walking or in the water in the same zone (fig. 15).

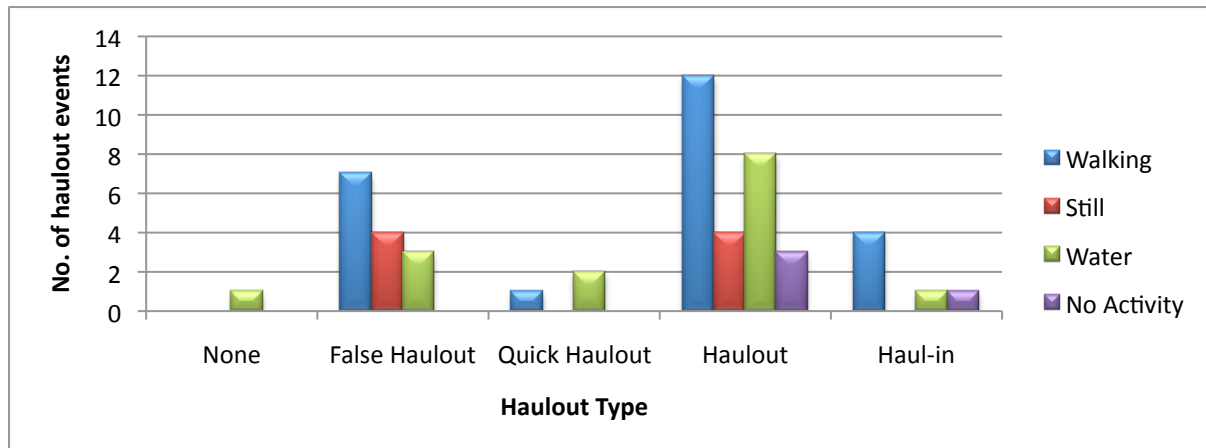


FIGURE 15. The number of haulout events observed in the same zone human activities were taking place on the beach. Human Activities: walking, still (sitting or standing), water (water activities, including swimming and surfing), and no activity (no people in the same zone as the sea lion activity).

Juveniles and unidentified sea lions hauled out In Zone A more than the other age classes (three haul-out events). Juvenile and sub-adult male sea lions hauled out in all study zones and other areas of the beach and campground. These age classes also contain the only identified sea lions to haul-out in the decoy zone (Zone C; Juv – n = 2, SAM – n = 1). Adult females were only observed to haul out beyond the study zone (n = 2). Whereas adult males only hauled up in zone A (fig. 16).

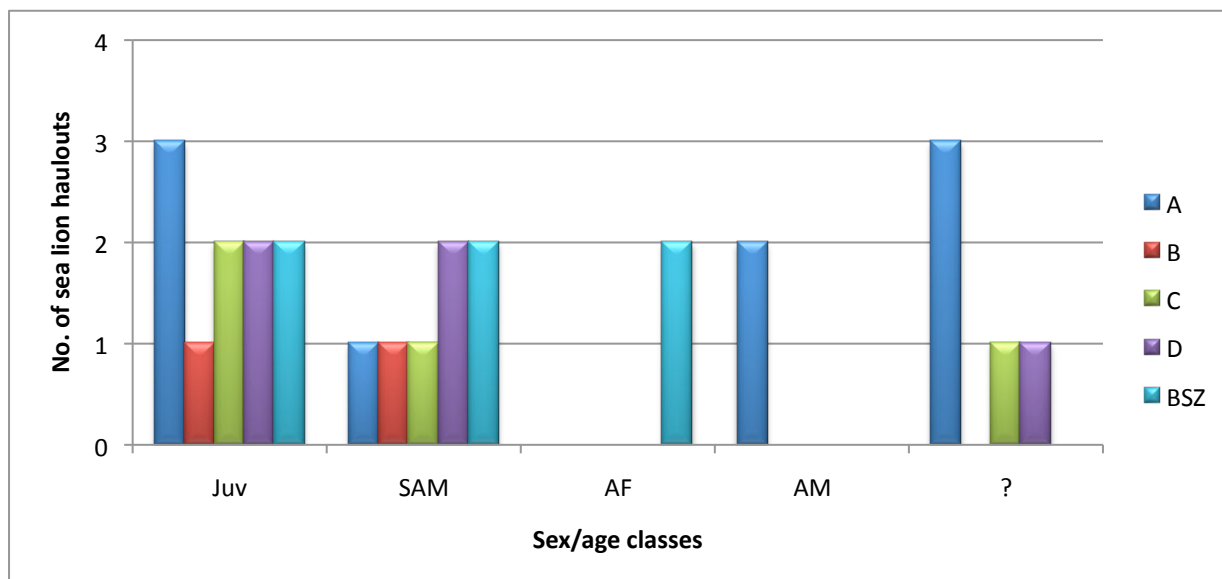


FIGURE 16: The number of sea lions (by sex/age class) to haul-out on the beach (Zones A, B, C and D), and beyond the study zone (BSZ). Sex/age classes: Juv – Juvenile sea lions; SAM – Sub-Adult Males; AF – Adult Female; AM – Adult Male; ? – Unidentified.

Discussion

General observations

Phocarctos hookeri of both sexes and most age groups (except pups) were observed to haul-out on Curio and Porpoise Bay beaches. The most frequently observed sex/age class of *P. hookeri* observed was sub-adult male. Sub-adult males are notoriously migrant, and “stragglers” are often observed hauling-out away from breeding sites as they hold no territories or females (Walker & Ling, 1981). Additionally, other non-breeding animals and first-time breeders may disperse to avoid intraspecific harassment (Grandi et al., 2008; McConkey et al, 2002). Juvenile males are said to be the drivers of dispersion in polygenous species, as unlike juvenile females, they are less tolerated by the breeding adults at the colonies, and are not bound to the breeding location – (as for pup-nursing females – site fidelity) (McConkey et al., 2002). Similarly to other migrants, juvenile males avoid harassment by other males by dispersing to non-breeding sites regularly for a number of years until they reach breeding age (Walker & Ling, 1981).

Beentjes (1989) conducted a similar observational study on *P. hookeri* at Papanui Beach on the Otago Peninsula, which observed similar results to the Catlins study under discussion. Over a two-year period, 14 male sea lions were identified on the beach; four sexually and socially mature males (potentially breeding), eight sexually but not socially mature males, and two immature males. 95% of the haulouts observed were by nine identifiable resident male *P. hookeri*. These ‘resident’ males were observed “returning on a regular basis, suggesting a high degree of site specificity” (Beentjes, 1989).

In this study, an adult female *P. hookeri* was observed on multiple occasions lying on the south side of the creek on Porpoise Bay beach. She appeared to be pregnant, and was only seen between the 7–30th Dec, 2010. It is possible that she found a less-populated, quiet location to give birth (McNally et al., 2001). Female *P. hookeri* have been observed to use beach-front forest to avoid male harassment (Auge et al., 2009; McConkey et al., 2002; Miller, 1991). Pregnant females have been frequently noted to “...congregate at isolated haul-outs some distance from the main rookeries” (King, 1995).

A local person reported observing a female sea lion give birth to a pup in the bushes in the yard of one of the houses with beach access, three years prior to this breeding season. However, the young pup was said to have died within weeks. The mortality may have been as a result of human disturbance, as anthropogenic disturbance of rookeries can result in displacement of animals and/or stress on nursing females and pups, even to the point that the pup is abandoned (Labrada-Moartagon et al., 2005). The establishment of new colonies is highly dependent on the dispersion of juvenile females (< 4yrs), which are not constrained by a pup, and are more likely to breed in a new location if they are first-time breeders (Grandi et al., 2008; McConkey et al, 2002). Additionally, the immigration of females to new sites is more likely if the area supports other *P. hookeri* (McConkey et al, 2002). Although the females in Otariid species tend to avoid male harassment, adults of both sexes seek and tolerate contact when the females are in oestrus (Miller, 1974). Oestrous female Grey and Southern Elephant seals have been observed to actively seek males on occasion (Miller, 1974). This behavioural change in oestrous females is likely the result of hormonal suppression of aggression (Miller, 1974), a trait likely derived to increase mating success.

However, in general “unprovoked antagonism by females toward males is the rule among pinnipeds” (Miller, 1974). Yet, likely due to the low number of females observed over the study, the only incidences of aggression displayed between sea lions on the beach was between Juvenile and sub-adult male *P. hookeri*. Generally, antagonistic behaviour in the species is rare apart from certain interactions between males – “confrontation on position in the hierarchy appears to be restricted to sub-adult and juvenile males.” (Walker & Ling, 1981). On the few occasions when aggressive interactions were seen, these were most likely play-fights between young males which are important for the natural development of competition and hierarchy displayed between territory-holding adult males (Harcourt, 1991; Miller, 1974). The young males did not appear to jostle with the intention to inflict pain, there was more display than contact between the sea lions. Juvenile and sub-adult males were observed play-fighting on a number of occasions, both on the beach and in the shallow water of Porpoise Bay. This behaviour is commonly displayed by adult males in a more aggressive manner, they are observed to fight on land or in shallow water for territories within breeding colonies (Miller, 1974).

Spatial Distribution/Occupancy

The spatial surveys of *Phocarctos hookeri* in the Porpoise/Curio Bay area (Jan/Dec) revealed that the age, sex and reproductive status of *P. hookeri* hauling out in the Porpoise Bay are characteristic of non-breeding, migrant sea lions either resident to, or visiting the beach (McConkey et al., 2002).

Two adult females identified during the study displayed different yet clustered distribution patterns in the area. A young adult female *P. hookeri* was primarily seen on the populated, southern-end of the beach, and was one of only a few individuals known to have repetitively rested among tents and motor-homes in the campground. A second (presumably pregnant) adult female, was only observed a small number of times near the creek on the southern-end of the beach.

Three large adult males had hauled out on the north-end of the beach on Jan 17th. All three were obviously marked, either branded, bleach-marked, or both.

Sub-adult males were the only sea lions to be observed on the small, pebbly beach of Curio Bay. This may be because of the limited soft sand, space and shelter offered by the small inlet. No juvenile females or pups were observed during the study. Curio Bay is not yet a breeding site, thereby pups are an unlikely site on the beach at this stage. Juvenile females are accepted among the pups and adults for longer than males (McConkey et al., 2002), hence they too are unlikely to be seen in the area.

Adult males and one sea lion of unidentified age or gender, were the only *P. hookeri* seen at the northern end of Porpoise Bay beach. Adult males were not seen in close proximity to any other sea lions on Porpoise Bay beach over the study period.

Sea lion Activity

Phocarctos hookeri haul-out on Porpoise Bay beach throughout the day, however juvenile and sub-adult males were the most prevalent visitors on the southern end of the beach, and sea lions were generally observed more frequently over middle hours in the day. Otariids are often more active at dawn and dusk when temperatures are cooler (Miller, 1991). Male *P. hookeri* at a similar non-breeding haul-out site were observed to spend 90% of their time lying down in the summer and 80% in winter (Beenjes, 1989). One juvenile male *P. hookeri* undergoing a moult with distinctive natural markings was frequently observed on the beach, more so towards the southern end of the beach. Additionally, the sea lion was observed on sand through-out daily observations from 7:00am to 9:00pm. Pinnipeds undergoing a moult require high peripheral temperatures to compensate for their loss of hair. Therefore, they tend to be lethargic as they typically eat little or fast, due to a reduction in their resting metabolic rate (Miller, 1991).

Less sea lions may have been observed at the early and late hours of the day if they retired to sheltered locations in the sand dunes or in the flax within the camp site where they are hard to detect unless their tracks are visible (fig. 16). Alternatively, higher diurnal activity on the beach during daylight hours may reflect nocturnal feeding (Beentjes, 1989). Beentjes (1989) observed male *P. hookeri* spent an average of 43.8% of the day ashore – 78% of daylight hours.

Sea lions tended to stay alert after moving or being approached or disturbed by people. Alert or tense behaviour in sea lions is often indicative of anti-predatory behaviour (Miller, 1991). Sea lions may be more vigilant on land as terrestrial locomotion is more difficult for their aquatically-evolved anatomy.



FIGURE. 16. *P. hookeri* tracks on Porpoise Bay beach, The Catlins. ^a. An adult male at the termination of distinctive tracks in the sand made by the sea lions flippers as he walked. The disturbed sand where the track changes direction indicates where the sea lion lay down. ^c. Similar tracks were frequently seen on the beach, ^b and often lead to a sleeping sea lion in the sand dunes.

Although there was only one event during which a sea lion was obviously attracted to (or interested in) the decoy, there were other incidents when human disturbance to a sea lion attempting to haul-out in the decoy zone may have disrupted the sea lions reaction/interaction with the decoy. Human disturbance was often the result of tourists chasing sea lions moving on and around the beach in an attempt to get photos. Smaller (juvenile) sea lions especially, were observed to return to the water when approached whilst they were in the process or had recently hauled out. Additionally, the results are inconclusive due to small sample sizes, which indicate however, that there were a limited number of *P. hookeri* hauling out in Porpoise Bay.

The lack of success in attracting sea lions with decoys limited the number of factors which could be scrutinized as increasing or decreasing the attractiveness of the decoys. Decoys of different sizes, colours (visual characteristics of the age and sex of *P. hookeri*), were arranged in various group sizes. Such variation would be useful to determine what characteristics make the decoy(s) attractive to various age/sex classes of *P. hookeri*. Social-seeking behaviour and tolerance of other individuals in otariid species is often dependent on age, sex and time/location (e.g. the breeding season) (McConkey et al., 2002; Miller, 1974). Auge and Chilvers (2010) conducted decoy study on *P. hookeri* at Sandy Bay, Enderby Island, and recorded success in attracting females to haul-out on specific areas of the breeding beach. Groups of one to three white artificial decoys (the same as used in this study), attracted 54% of females coming ashore, of which 73% came close enough to sniff the decoys. However, the Catlins study differed significantly over a suit of factors, and despite using the same female decoys used in the Auge and Chilvers study (plus newly constructed male decoys), did not return the same conclusive results.

However, sea lions of different age/sex were observed in close proximity and contact on a number of occasions (fig. 17). *P. hookeri* at Curio Bay showed infrequent interest in both one another and the decoys. It was suggested that the use of the decoys as a visual stimuli may be ineffective for attracting sea lions without the accompaniment of a chemical stimulus (pheromones). However, attracting sea lions from a distance may be useful for moving sea lions, whilst pheromones may be required to extend the time sea lions are interested/stay in the proximity of the sea lion. There is evidence to suggest that sea lions have strong “equivalence relations” (Schusterman & Kastak, 1998), meaning they are able to associate objects to a suite of reinforcing stimuli (e.g. appearance, smell, vocalizations). Miller (1991) suggests that sea lions may communicate through their physical contact, movement and reactions, more so than through displays. Associative learning is applicable to sea lions in a number of contexts including; social, communicative, foraging and predator-avoidance. Thereby, multiple stimuli may be required to attract sea lions to specific areas on a coastline.



Figure 17. *Phocarctos hookeri* observed lying in close contact on Porpoise Bay beach in the Catlins. A&B; A sub-adult male and a Juvenile male. C; Two sub-adult males. D; A sub-adult male and an adult female.

Therefore, there are a number of factors concerning the decoys which may have influenced the success of using such methods. The initial trial of these decoys (Auge & Chilvers, 2010) was conducted under a number of different conditions, which thereby make it hard to pin-point a single cause for the lack of success in attracting sea lions to Curio Bay. Such factors included; the local population size (Auckland Isl: ~10,000; Catlins region; ~100 (Childerhouse & Gales, 1998)) weather, location and most significantly, is the difference between a haul-out site and rookery in terms of the sea lions' motivation for hauling out.

Alternative/Supplementary Solutions

The challenge of translocation of pinnipeds and other marine species is that they often return to their original location due to characteristically high site fidelity and philopatry (Chilvers & Wilkinson, 2008). So how successful would decoys be at relocating sea lions in the long term? Unfortunately, our results cannot answer this question, however the event in which a sea lion was attracted to the decoy, it remained within its proximity for only four minutes.

Other options for reducing human-sea lion interactions include fencing off areas of high human/vehicle traffic, and providing/restoring preferential habitat for sea lions in areas of minimal human activity.

Dogs should also be restricted around sea lions, whether by enforcing owners to keep dogs on a leash, or assigning temporary or permanent 'no-dog zones' around important haul-out sites or sensitive animals. Females and pups are the most vulnerable to disturbance (especially over breeding, nursing and rest periods), and dog attacks on sea lion pups are a recorded threat (McConkey et al., 2002).

Restricting sea lion use of human-inhabited areas such as the Curio Bay Campsite may be necessary in order to discourage the sea lions which currently use the campground, and avoid other sea lions from following their example which would ultimately escalate the problem. Fencing, boardwalks and gates are successfully used as a management tools to encourage species to return to an area by separating protecting wildlife and restricting human disturbance animals and their environment.

“It’s always the ones with the biggest lenses that have to get closest.” – Anonymous. This comment was made in regards to photographers getting too close to Yellow-eyed penguins at Curio Bay.

Australian Fur Seals (*Arctocephalus pusillus*) began hauling-out on a rock platform at Cape Couedic following the construction of a boardwalk and railing which reduced significantly reduced human disturbance to the seals (Shaughnessy et al., 2010). Such results reinforce the importance of restricting human access to sites used by pinnipeds for resting, mating and nursing pups.

Providing suitable and preferential habitat for *Phocarctos hookeri* on the mainland away from human-populated or high use areas would likely encourage sea lions to establish on the mainland, whilst keeping human-sea lion interactions (disturbance) at a minimum (Lalas & Bradshaw, 2003). Haul-out sites of *P. hookeri* are commonly selected for certain habitat qualities, including; sandy beaches as *P. hookeri* use sand to thermoregulate (Miller, 1974). *P. hookeri* ‘flip’ sand onto their backs with their flippers to cool themselves whilst lying on the beach. This behaviour also requires unpacked sand, hence sea lions tend to lie above the high tide line in the soft sand and away from water (Walker & Ling, 1981). However, flat-rock benches are also used as haul-out platforms (Miller, 1974), and large flat areas of hard-packed sand are used by *P. hookeri* for pupping and mating (Gales and Fletcher, 1999).

Additionally *Phocarctos hookeri* have been observed to travel up to 1.5km inland, and at altitudes of up to 250m (McNally et al, 2001; Walker & ling, 1981). Females commonly use forest adjacent to a beach to provide shelter for pups and/or avoid male harassment (Walker & Ling, 1981). Haul-out sites on the Sub-Antarctic Islands are often sandy beaches backed by grassland and/or forest (Gales & Fletcher, 1999), hence maintaining and/or restoring the extended environment of sea lion haul-out sites (including forests, dunes and tussock). Sea lion observations and sign (e.g. tracks, excrement), are indicative of sea lion use of an area. *P. hookeri* were often observed sleeping in tussock on the dunes which back the majority of the length of Porpoise Bay beach (fig. 18). Sub-adult males and adult females were observed in the campground over the two-month period. However, sea lions have been routinely using the campground for a longer period of time. *P. hookeri* were observed sleeping in the thick flax bushes which separate the campsites, on the mown grass lawns in front of the camp store, in the car park and next to tents and motor-homes. Sea lions likely utilize the large flax bushes in the campsite as they provide good shelter from the strong winds which batter the exposed headland. There is little other foliage adjacent to the beach which provides protection for sea lions in the Curio Bay area, leaving the sea lions little option but the campsite, or the backyards of private homeowners on the beach front for shelter. Therefore, replenishing natural shelter (such as forest/flax) for *P. hookeri* at the northern end of Porpoise Bay beach in particular, may provide the incentive required for sea lions to preferentially haul-out at the less-populated end of the beach.



FIGURE 18. Sub-adult male *P. hookeri* sleeping in the tussock at the base of the dunes, north of the creek and housing on Porpoise Bay beach.

In all efforts to minimise human/sea lion interactions (especially those resulting in disturbance to the sea lions natural behaviour), it is crucial not to discourage sea lions from hauling up in the area. Instead, it would be more beneficial to the conservation of the species, the New Zealand tourism industry, and the local residents and visitors of the Catlins region and further abroad if sea lions can be attracted or encouraged to haul out in the less populated areas. Enabling the sea lions to relocate on their own terms is more likely to have a greater success rate than translocation. Additionally, *Phocarcos hookeri* haul-out sites such as Curio Bay, and like most of the locations at the northerly reaches of their current range) are important for the process of re-colonisation (McConkey et al, 2002). Haul-out sites change in social composition over time, which often eventuates in the formation of new breeding colonies (Grandi et al., 2008).

Recolonization of the New Zealand mainland by *P. hookeri* will only be evident if the population increases in size, and new haul-out sites and breeding colonies are established (Grandi et al., 2008). The establishment of new breeding colonies beyond the Auckland Islands is vital in the process of reducing the species to a 'non-threatened' state (McConkey et al., 2002). However, recolonization is rare in philopatric species, especially when population density is low, stable or declining as is the trend for *P. hookeri* (Chilvers & Wilkinson, 2008). The recolonization process is likely to remain slow for the species (Lalas, 2008), and may require additional management intervention, as *P. hookeri* is a highly philopatric species, most often bound to a breeding colony by strong site fidelity (Chilvers & Wilkinson, 2008). Therefore, the chance of females breeding at localities great distances from their birth-place is low, as the New Zealand mainland ~600 km from the Auckland Islands (Google Earth, 2011; Grandi et al., 2008; McConkey et al, 2002). New Zealand fur seals and other otariids display similar modes of dispersion; as a population grows and space becomes limited, individuals must disperse away from the focal colony (McConkey et al., 2002). However, philopatry and site fidelity often bind gregarious species to their birthplace and breeding colony, so that population growth drives dispersion in a "spill-over" effect (Grandi et al, 2008) - where "new breeding colonies cluster around established breeding colonies" (McConkey et al., 2002; Miller, 1974).

Although the effectiveness of decoys for attracting sea lions onto non-breeding, mainland beach remains inconclusive, the study provided a survey of *Phocarctos hookeri* activity on Porpoise Bay beach and adjacent areas over the two breeding months of summer. To identify if there are resident *P. hookeri* in the Curio Bay area, repeated sightings of marked individuals over several years would be required (McConkey et al, 2002). Further study of new and establishing haul-out and breeding sites of *P. hookeri* on the mainland will be crucial for successfully managing interactions between sea lions and the public, as well as the recovery and re-establishment of the population on mainland New Zealand.

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