

## A NORTHWARD SPREAD IN THE BREEDING DISTRIBUTION OF THE NEW ZEALAND SEA LION *PHOCARCTOS HOOKERI*

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The primary objective of the population management plan for New Zealand sea lions, *Phocarctos hookeri*, is to move the species from its current conservation status of 'Threatened' to 'Non-threatened'. The mechanism by which this will occur is through the establishment of new breeding colonies away from the only existing colonies at Auckland Islands and Campbell Island. Otago, on the southeast coast of the South Island of New Zealand, is one of only three locations where breeding has been recorded away from these islands in modern times. We found only one female at the initiation of our surveys here in 1991, an individual that had been tagged as a pup at Auckland Islands. This female has remained resident at Otago and is now breeding. Her first live birth, in the 1993/94 breeding season, represented the first record of a *P. hookeri* pup on the New Zealand mainland since the elimination of the species here by humans c. 150 years ago. Up to and including the 2000/01 breeding season she had produced six pups. Her surviving pups have remained at Otago and her eldest two daughters have started breeding, producing a further three pups. From this total of nine live births, two pups have died. Although 6 - 8 other migrant females have been recorded, to our knowledge none have bred at Otago. We conclude that the initiation of breeding by *P. hookeri* at Otago has been a serendipitous event attributable to atypical behaviour by a single female.

Key words: New Zealand sea lion, *Phocarctos hookeri*, breeding, Otago, distribution, conservation.

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THE breeding distribution of the New Zealand sea lion, *Phocarctos hookeri*, is highly localised, with over 95% of annual pup production at Auckland Islands (Gales and Fletcher 1999) and almost all of the remainder at Campbell Island (McNally *et al.* 2001) (Fig. 1). The breeding season, December and January, encompasses the birthing period (mean pupping date 17 - 20 December) followed by copulation approximately one week later (Cawthorn *et al.* 1985). Females produce their first pup at four years and can pup annually thereafter (Cawthorn *et al.* 1985). Males occupy territories at rookeries where females aggregate in groups of 8 - 25 animals (Cawthorn *et al.* 1985). The most recent population estimate for *P. hookeri* is c. 13,600 for the 1995/96

breeding season (Gales and Fletcher 1999). Pup production at the most comprehensively studied breeding colony, Sandy Bay, appears to have been stable for the 22 years from 1972 - 1994 (Gales and Fletcher 1999).

There is an incidental kill of *P. hookeri* in the seasonal trawl fishery targeting squid around Auckland Islands. This was first identified as a conservation issue in the late 1970s (Anon. 1991) and a 12 nautical mile fisheries exclusion zone was implemented around Auckland Islands in 1982 to protect *P. hookeri* (Manly and Walshe 1999). In response to continued incidental mortality a maximum allowable fisheries related mortality

(MALFIRM) was implemented in 1992 (Manly and Walshe 1999). *P. hookeri* is currently designated as 'Threatened' under the New Zealand Marine Mammals Protection Act 1978 due to the small number of distinct breeding populations (Manly and Walshe 1999; Maunder *et al.* 2000). As a requirement of this Act, the New Zealand Department of Conservation (DOC) is developing a population management plan with the primary objective of moving *P. hookeri* from 'Threatened' to 'Non-threatened' status within 20 years (Manly and Walshe 1999; Maunder *et al.* 2000). This can be done with the establishment of new breeding locations away from Auckland Islands and Campbell Island (Maunder *et al.* 2000). The management strategy aims to limit kills of *P. hookeri* in the squid fishery so that bycatch will not effect population recovery at Auckland Islands. The underlying assumption is that the resulting increase in abundance and concomitant density-dependent factors at Auckland Islands will lead to emigration as the population nears carrying capacity (Maunder *et al.* 2000), and emigrants from Auckland Islands will breed elsewhere.

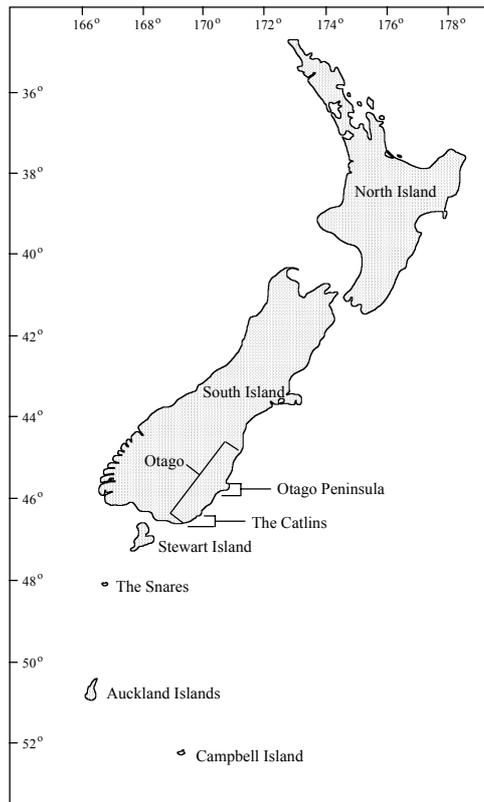


Fig. 1. Map of New Zealand showing sites important to *P. hookeri* breeding and distribution.

*Phocarctos hookeri* had a more widespread distribution before the arrival of humans *c.* 1000 years ago (Smith 1989). Hunting, first by Maori and later by Europeans, eliminated them from the North Island, the South Island and Stewart Island (Smith 1989; Childerhouse and Gales 1998) (Fig. 1). There are only two historical records for breeding on the mainland: 1826 for Stewart Island (Howard 1940) and prior to 1863 for the west coast of the South Island (Hector 1892). Recent discoveries of sub-fossil bones of pups near the northern tips of the South Island (Worthy 1994) and the North Island (Gill 1998) have not only verified past breeding in these locations but also indicate that breeding could have been widespread around mainland New Zealand.

Otago, in the southeast of the South Island, now marks the northern limit of year round presence by *P. hookeri* (McConkey *et al.* 2002a). Residence has been demonstrated by repeat sightings of identified immigrant males over several years (McConkey *et al.* 2002a). The population estimate for immigrant *P. hookeri* at Otago in 1999 was 108 males and three females (McConkey *et al.* 2002a). In this paper we document the recent initiation of breeding by *P. hookeri* at Otago. We discuss the implications of this breeding in the context of an expansion of the current breeding range from an isolated origin, and relate it to the management strategy for the species.

## METHODS

This study documents breeding by *P. hookeri* at Otago up to and including the 2000/01 breeding season. Our records for *P. hookeri* at Otago began with incidental sightings by CL during surveys of seabirds initiated in 1979. Some *P. hookeri* pups have been tagged at Auckland Islands in most years since 1980 (Cawthorn 1993). Numbers on these flipper tags become illegible with time but, starting with the 1984/85 breeding season, some cohorts are differentiated on tags by unique patterns of holes and indentations. The only published key for these patterns, Lalas and McConkey (1994), has a mistake: entries for 1989/90, 1990/91 and 1991/92 should read 1990/91, 1991/92 and 1992/93, respectively. Regular monitoring at Otago of *P. hookeri* that had been tagged as pups at Auckland Islands began in June 1991 (Lalas 1997). All sightings of females were also recorded. From January 1995 to July 2001, *P. hookeri* sighted at Otago were photographed following McConkey (1999). Animals with distinctive features recognisable from photographs were designated as 'identified', and others were designated as 'unidentified'. Results for this period are based on data collated from regular surveys and site descriptions by McConkey (1997), Heinrich

(1995, 1998), McNally (1996, 2001), and McConnell (1998, 2001).

The two major aggregations of *P. hookeri* at Otago, Otago Peninsula and The Catlins (Fig. 1), were studied separately. Photographic identifications were checked throughout the study period in order to ensure that all identifications were unique. The ages of male *P. hookeri* were estimated based upon physical features recorded from tagged animals of known age (McConkey *et al.* 2002b). Female *P. hookeri* were estimated as being one year, two years, three years, or adult ( $\geq 4$  years) based upon physical features recorded from animals of known age born at Otago. Confirmation of sex for young animals was based upon presence or absence of a penile opening. All but one of the surviving pups born at Otago were tagged to aid identification. Survey effort was variable throughout the study, with 3 - 91 survey days per year, 1991 - 2001.

Four intensive, short-term studies (three involving focal animal sampling and one involving beach surveys three times a day) targeting the behaviour of mother-pup pairs were conducted in addition to regular surveys. These intensive studies were conducted between April and August in 1994 (McConkey 1994), 1996 (Borofsky 1997), 1998 (Parker 1998), and 2001 (Schimanski 2001). Attendance patterns of female seals are often recorded using remote sensing devices which record presence ashore but not the amount of time the mother spends with her pup. We have calculated estimates for both events. As most of our studies focused on observing the pups we were able to calculate the proportion of observation time for which the mother was present with her pup. The proportion of time the mother was ashore was calculated as a proportion of observation days rather than observation time as it was impossible for us to tell exactly when the mother arrived ashore. These calculations excluded any nocturnal observations and any time the mothers may have spent ashore at other beaches. In addition, behavioural data were also collected opportunistically throughout the entire study period. Behavioural observations were conducted in daylight from a distance of 10 - 50 m.

## RESULTS

Since the beginning of regular monitoring in 1991, only six migrant female *P. hookeri* have been identified at Otago (Table 1). The first breeding female in Otago, referred to as the 'founder female' for the remainder of the paper, was first identified in 1991, at which time she possessed a tag indicating she was tagged as a pup at Auckland Islands in the 1986/87 breeding season. Two additional females

(Migrant 3 and Migrant 4) have been sighted regularly over a number of years. Migrant 3 was estimated as a two year old in 1995 and was assigned to the 1992/93 cohort. Migrant 4 had been tagged as a pup in the 1990/91 breeding season at Auckland Islands. Of the remaining three females, two (Migrant 2 and Migrant 6) were first seen as adults and could not be assigned to cohorts. The remaining female, Migrant 5, was estimated to be one year old in 2000 and was assigned to the 1998/99 cohort. Migrant 4 has been sighted during three consecutive winters, 1998 - 2000, and is known to have given birth at Auckland Islands during the 1999/00 breeding season (I. Wilkinson, pers. comm.). Sightings of unidentified migrant females accounted for a further 1 - 3 individuals. Therefore, a total of 7 - 9 migrant females were recorded at Otago through 11 years, 1991 - 2001.

The founder female (standard length 1.8 m in 1995) aborted a foetus in October 1992 at Victory Beach (Fig. 2). She has since given birth to six pups (Table 2). The first five of these pups were born at Taieri Mouth (two in a residential backyard adjacent to the beach), c. 50 km south of Otago Peninsula (Fig. 2). The most recent pup was born at Blackhead Beach (Fig. 2), between Taieri Mouth and Otago Peninsula, a public beach used regularly by people, dogs and horses. Two of the founder female's six pups are known to have not survived (Table 2). Pup 6, born in 1999/00, was found dead at Otago Peninsula in February 2000. The cause of death could not be ascertained due to the degree of carcass decomposition. Pup 7, born in 2000/01 was seen alive on only one date (25 January 2001) at its assumed parturition site, Blackhead Beach. Five days later the founder female was observed searching and calling at this site but was not seen with the pup. Subsequent searches by people at this site also failed to locate the pup. The founder female was sighted regularly following 25 January 2001 without her pup, hence we conclude that it did not survive. Pup 5 was bitten by a Rottweiler dog at two weeks old but survived the attack.

The surviving offspring of the founder female have remained at Otago Peninsula. Pup 1 and Pup 2 have started breeding, giving birth to an additional three pups (Table 2). These three births have occurred at Otago Peninsula, approximately 50 km north of their natal beach. Pup 1 has given birth on two different beaches at Otago Peninsula, Papanui Beach and Victory Beach, 4 km apart (Fig. 2). Pup 1 also appeared pregnant when seen on 5 December 1999 but, although this female was later seen in January 2000, no pup was found. An aborted foetus was found at Victory Beach on 20 September 1999.

|                        | Cohort             | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 |
|------------------------|--------------------|------|------|------|------|------|------|------|------|------|------|------|
| <b>Otago Peninsula</b> |                    |      |      |      |      |      |      |      |      |      |      |      |
| Sampling effort        |                    | 14   | 17   | 12   | 56   | 91   | 19   | 26   | 23   | 19   | 24   | 36   |
| Founder female         | 86/87 <sup>a</sup> | 3    | 9    | 2    | 18   | 28   | 9    | 9    | 6    | 2    | 1    | 8    |
| Migrant 5              | 98/99 <sup>b</sup> | -    | -    | -    | -    | -    | -    | -    | -    | -    | 3    | -    |
| Unidentified           | -                  | -    | -    | -    | -    | 1    | 3    | 5    | 2    | -    | -    | -    |
| <b>The Catlins</b>     |                    |      |      |      |      |      |      |      |      |      |      |      |
| Sampling effort        |                    | 4    | 8    | 3    | 5    | 29   | 52   | 28   | 20   | 31   | 19   | 4    |
| Founder female         | 86/87 <sup>a</sup> | -    | -    | 1    | -    | -    | -    | -    | -    | -    | -    | -    |
| Migrant 2              | -                  | -    | -    | -    | 1    | 1    | 1    | -    | -    | -    | -    | -    |
| Migrant 3              | 92/93 <sup>b</sup> | -    | -    | -    | -    | 15   | 14   | 3    | 4    | 3    | 3    | -    |
| Migrant 4              | 90/91 <sup>a</sup> | -    | -    | -    | -    | -    | -    | -    | 3    | 5    | 1    | -    |
| Migrant 6              | -                  | -    | -    | -    | -    | -    | -    | -    | -    | -    | *    | 1    |
| Unidentified           | -                  | -    | -    | -    | -    | -    | 11   | 4    | -    | -    | -    | -    |

Table 1. Sightings of migrant and immigrant female *P. hookeri*: at Otago, June 1991 to July 2001 (<sup>a</sup> tagged animal - known cohort; <sup>b</sup> untagged animal - estimated cohort; Unidentified - represents multiple sightings of a total of 1-3 individuals at Otago; \* indicates first sighting of Migrant 6 at Waldronville (Fig. 2)). Sampling effort is in days.

| Mother         | Pup    | Sex of Pup | Season of birth | Site of birth | Site of nurture | Tag   | Age (years) of pup in 2001 |
|----------------|--------|------------|-----------------|---------------|-----------------|-------|----------------------------|
| Founder female | Pup 1  | Female     | 1993/94         | T             | V, R            | 0350  | 7                          |
|                | Pup 2  | Female     | 1995/96         | T             | V               | -     | 5                          |
|                | Pup 3  | Female     | 1997/98         | T             | V               | A1737 | 3                          |
|                | Pup 5  | Male       | 1998/99         | T             | V               | B1401 | 2                          |
|                | Pup 6* | Female     | 1999/00         | T             | V               | -     | -                          |
|                | Pup 7* | Male       | 2000/01         | B             | V               | -     | -                          |
|                | Pup 1  | Pup 4      | Male            | 1997/98       | P               | V     | A1738                      |
| Pup 8          |        | Female     | 2000/01         | V             | V, S            | 2577  | 0                          |
| Pup 2          | Pup 9  | Male       | 2000/01         | V             | V, S            | 2576  | 0                          |

Table 2. *Phocarcos hookeri* births at Otago (Site of nurture = main location(s) of pup until independence; Pups numbered in chronological order; \* = pup died  $\leq$  2 months old; T = Taieri Mouth; V = Victory Beach; R = Ryans Beach; B = Blackhead Beach; P = Papanui Beach; S = Sandfly Bay; these sites are shown in Fig. 2).

It is likely that it belonged to Pup 2 as Pup 1 was apparently still pregnant after this date, the founder female gave birth to a live pup that season, and no other females of reproductive age were in the area. The founder female moved with each of her surviving pups to Victory Beach within three months of their birth. Pup 1 also moved her first pup to Victory Beach at about the same time as the founder female. In 2000/01 when Pup 8 and Pup 9 were born at Victory Beach both moved with their mothers to Sandfly Bay in June 2001, within days of one another. This occurred at about the same time that the founder female also began to visit Sandfly Bay. The beach used most regularly by females with pups, Victory Beach, has a plantation of exotic pine trees, *Pinus radiata*, abutting foreshore sand dunes. This forest was frequently used as a haul-out and rest area by mothers with pups and by the pups when alone. Male *P. hookeri* were seldom seen amongst these trees unless in the company of females or pups, although they were regularly seen on the beach.

The founder female was protective of her pups and often exhibited aggression towards males of all ages, frequently in response to her pup's call. On two

occasions she was seen to interpose herself between her pup and males larger than herself, and to draw blood by biting the neck and chest of these males. However, on other occasions she was unable to drive large males away and was separated from her pup for up to two hours. The founder female was also observed interposing herself between an aggressive male and a pup that belonged to Pup 1. On 5 July 2001, Pup 3, who had not yet given birth, was observed vocalising, using calls typically associated with adult females calling for pups. On the same date she was observed following the calls of Pup 8 (offspring of Pup 1), and subsequently interposed herself between the pup and an aggressive male.

During the focal animal behaviour studies, *P. hookeri* mothers showed attendance rates ashore of 73 - 93% (founder female - 1994, 1996, 1998), 40 - 55% (Pup 1 - 1998, 2001), and 58% (Pup 2 - 2001) of observation days (Table 3). On several occasions mothers were present on the beach, but unable to locate their pups despite frequent calling. The proportion of observation time that mothers spent with their pups was 46 - 70% (founder female) and 35% (Pup 1) (Table 3). Pups have remained with

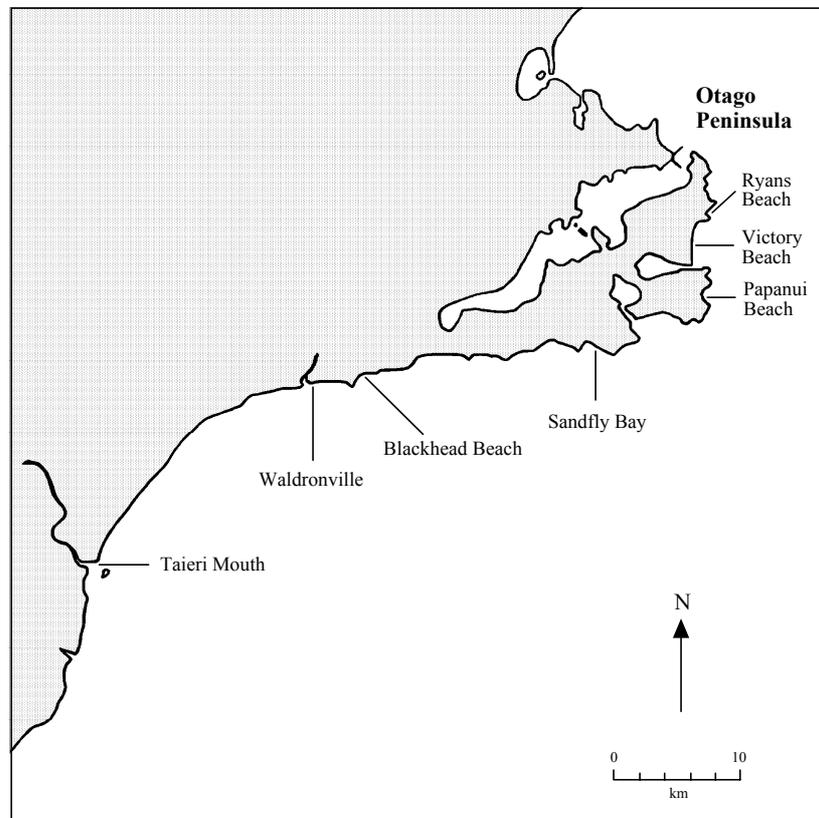


Fig. 2. *P. hookeri* breeding and nurturing sites at Otago, South Island, New Zealand

| Mother         | Pup   | Observation period |       | Mother ashore<br>% of days<br>(number) | Mother with pup<br>% of hours<br>(number) | Study site | Duration of study        |
|----------------|-------|--------------------|-------|--|---|------------|--------------------------|
|                |       | days               | hours |  |   |            |                          |
| Founder female | Pup 1 | 11                 | 30.5  | 73 (8)                                 | 54 (16.4)                                 | V          | 2 June - 12 Aug 1994     |
| Founder female | Pup 2 | 14                 | 89.1  | 93 (13)                                | 46 (41.2)                                 | V          | 15 April - 29 April 1996 |
| Founder female | Pup 3 | 10                 | 32.7  | 80 (8)                                 | 70 (22.8)                                 | V          | 17 April - 5 May 1998    |
| Pup 1          | Pup 4 | 10                 | 31.2  | 40 (4)                                 | 35 (11.0)                                 | V          | 17 April - 5 May 1998    |
| Pup 1          | Pup 8 | 9                  | n/a   | 55 (5)                                 | n/a                                       | S          | 22 June - 6 July 2001    |
| Pup 2          | Pup 9 | 12                 | n/a   | 58 (7)                                 | n/a                                       | S          | 22 June - 6 July 2001    |

Table 3. Attendance patterns of *P. hookeri* mothers at Otago (n/a – 1994 - 1998 studies consisted of focal animal sampling, 2001 study consisted of beach surveys three times per day). V = Victory Beach; S = Sandfly Bay.

their mothers until the birth of the next pup one, two or three years later, with Pup 4 observed suckling at approximately 2.5 years of age.

## DISCUSSION

*Phocarctos hookeri* currently has fewer than five breeding locations and for this reason is classified as 'Threatened' (Manly and Walshe 1999; Maunder *et al.* 2000).

Hence, the DOC population management plan regards species recovery of *P. hookeri* as being contingent on the establishment of new breeding colonies away from the population base at Auckland Islands and Campbell Island (Manly and Walshe 1999; Maunder *et al.* 2000). We suggest that a viable expansion of the breeding range of *P. hookeri* requires the following sequence of events: **1**) at least

one female must immigrate into a new area; 2) this female must then remain and survive in the new area; 3) this female must subsequently breed and exhibit site fidelity (repeated return to a single site for breeding); 4) the offspring of this female must remain in the new area and survive; and 5) these offspring must exhibit philopatry (repeated return to natal site for breeding). We address each of these prerequisites in turn.

### Female migration

Immigration is essential for the establishment of new colonies and accounts for much of their early growth (Stewart *et al.* 1994). Juvenile males form the vanguard of dispersion among polygynous mammals (Dobson 1982). Otago is the northern-most site with year round presence of *P. hookeri* (McConkey *et al.* 2002a). Through the five years 1995 - 1999, 113 migrant males and four migrant females were identified at Otago (McConkey *et al.* 2002a). This demonstrates that males predominate at the northern edge of distribution of the species. There are several mechanisms that may account for this. Females can produce their first pup when four years of age, suckle for up to one year, and can pup annually (Cawthorn *et al.* 1985). Therefore, once they have started breeding, most females are constrained by the needs of their pups, and are committed to remain in the vicinity of their breeding location as long as they have a pup and it survives (Cawthorn 1993; Gales and Mattlin 1997).

This constraint of females  $\geq 4$  years of age may partially explain the low levels of female dispersal, and the paucity of females in the population at Otago. For this reason it is the dispersal of juvenile females, whose movements are not constrained by the needs of a pup, that can be considered as fundamental for the expansion of the breeding range. Juvenile male northern fur seals, *Callorhinus ursinus*, are excluded from breeding areas until the male territorial structure breaks down at the end of the breeding season (Gentry, 1998). Low female dispersal could therefore be due to sexual discrimination of juveniles at breeding colonies, with females accepted but males driven off. This would result in a much higher number of juvenile females than juvenile males at the breeding colonies each summer. Harassment of females by males has been proposed as a key factor affecting the gregariousness in female otariids (Cassini, 1999). This harassment by males may discourage migrant females from remaining at new locations.

Most otariids show strong affinities for familiar terrestrial sites (Gentry 1998). High degrees of both philopatry and site fidelity in *C. ursinus* have been used to explain the limited capacity that this species

has for colonising new areas (Gentry 1998). Tag recoveries indicate that most female *P. hookeri* also return to their natal rookery each breeding season (Anon. 1991). Studies of New Zealand fur seals, *Arctocephalus forsteri*, at Otago Peninsula have shown that new breeding colonies cluster around established breeding colonies (Bradshaw *et al.* 2000). This demonstrates a preference for breeding at or near other breeding sites (Bradshaw *et al.* 2000). Therefore the isolation of the Auckland Islands and other subantarctic breeding sites for *P. hookeri* may further reduce the chances of new colonies establishing elsewhere.

### Female residency

Continual sightings of identified migrant males over several years have indicated that the majority become resident at Otago (McConkey *et al.* 2002a). Three of six identified migrant females at Otago were also seen regularly over several years though only one has produced any pups. Immigration of pinnipeds is more likely if the destination already supports a breeding colony of that species (Baker 1978; Gentry 1998). Therefore, as the number of breeding females at Otago increases, so does the likelihood of migrant females remaining. Given that numbers of breeding females at Otago are increasing (and will continue to do so) an increased retention rate of migrant females may simply be a matter of time.

Despite the presence of 7 - 9 migrant females in the region, the births at Otago have all descended from one female. Regular sightings of females post partum have not resulted in any observed copulations and paternity has not been determined for any of the pups born to date. An adult female *P. hookeri* (Migrant 4), tagged as a pup at Auckland Islands, was present at Otago for three consecutive winters (1998-2000), but gave birth at Auckland Islands in 1999/00. If philopatry is typical for female *P. hookeri*, then the pattern of return to Auckland Islands demonstrated by Migrant 4 can be expected from the majority of migrant females, rather than the unusual behaviour of the founder female.

### Site fidelity

Site fidelity by females after migration is important for the formation of a breeding colony. Since the birth of her first pup the founder female has demonstrated a high level of site fidelity. After the aborted foetus at Victory Beach five of the subsequent six births occurred at Taieri River Mouth.

### Pup survival

The survival rate to one year of age for the nine pups born at Otago was calculated as 0.78. This is the same as the estimated 'maximum value' for survival

of pups to one year old used in the population model for the Auckland Islands which is derived from data for other otariids (Gales and Fletcher 1999: 40). Two of the nine pups born at Otago died within their first two months of life. The remaining seven pups have survived until 2001 giving them a survival rate of 1.00 over this time. This rate is higher than the estimated 'maximum value' (0.95) for survival of females older than one year used in the population model for the Auckland Islands (Gales and Fletcher 1999: 40). The death of the two pups at Otago cannot be attributed to female inexperience because they were the 5<sup>th</sup> and 6<sup>th</sup> pups of the founder female. There may be several factors other than female experience that affect pup survival (e.g., infanticide, female attendance and human disturbance) and therefore may influence selection of a breeding site.

Incidents of infanticide and cannibalism have been documented for adult male *P. hookeri* at Auckland Islands (Wilkinson *et al.* 2000) and could potentially contribute to pup deaths at Otago. Pups of South American sea lions, *Otaria byronia*, born in colonies are more likely to survive than those born to solitary breeders (Campagna *et al.* 1992). The main causes of death were infanticide by young conspecific males and starvation following mother-pup separation and failure to reunite (Campagna *et al.* 1992). The subantarctic fur seal, *Arctocephalus tropicalis*, also showed a decrease in pup mortality as the population increased from low to medium density. As the female *P. hookeri* at Otago are currently solitary non-colonial breeders outside the usual harem situation, these same factors may affect pup survival at Otago in the future but have not been significant to date. At Otago, active and aggressive defence of her offspring, by the founder female, was observed on several occasions. Perhaps even more unusual was the defence of pups by females that were not their mothers, in particular, an immature female that has not yet had a pup of her own. The defence of pups by females is likely to decrease the potential for infanticide by male *P. hookeri*. Victory Beach is the only beach at Otago Peninsula with a forest abutting foreshore sand dunes. We suggest that the selection of this beach, and the use of the forest, by female *P. hookeri* is a deliberate attempt to avoid males. This isolation would further reduce the chances of infanticide by potentially aggressive males. *Phocarctos* mothers at Auckland Islands also make use of forests on the islands after they leave the breeding colonies, where they leave their pups while foraging (Cawthorn 1993).

The pattern of female attendance may be critical to the survival of pups. During summer lactating female *P. hookeri* at Auckland Islands spend an average of 43% of their time ashore and the

remainder of their time foraging at sea. During autumn and winter the founder female was sighted ashore on 73 - 93% of the behavioural observation days. This greater proportion of time ashore may reflect a more plentiful or closer food supply compared to that of females at Auckland Islands. An additional explanation is that seasonal differences in observation periods may account for the difference in female attendance. Attendance patterns show time spent ashore rather than time spent with the pup. At Otago the proportion of days spent ashore by mothers was sometimes substantially different to the proportion of observation time they spent with their pups. This may indicate an inability of females to immediately find their pups once ashore. Pups born to solitary breeders are more likely to wander than those born in colonies and therefore are more prone to failure to reunite with their mothers (Campagna *et al.* 1992). While solitary breeding continues at Otago failure to reunite may contribute to pup mortality in the future. However, the high survival rate of pups indicates this has not been an issue to date.

Humans deliberately killed at least six *P. hookeri* at Otago through three years, 1992 - 1994 (McConkey 1994). The dog attack on Pup 5 can also be indirectly attributed to the presence of people. Females, pups and yearlings are the demographic groups thought to be the most vulnerable to disturbance in pinnipeds (Salter 1979; Gerrodette and Gilmartin 1990). The frequency and intensity of anthropogenic disturbances will potentially be greater for females and pups on the mainland than on offshore islands as a result of their proximity to human habitation. Human disturbance may also disrupt breeding through interruption of nursing or rest periods. For this reason, increased protection of these individuals, through temporary prohibition of dogs on beaches frequented by pups or transportation to less public locations, could increase pup survival at Otago. The increased risk of disturbance is highlighted by the disappearance of the pup from Blackhead Beach, in which humans may have contributed to pup mortality.

### Philopatry

The only breeding by *P. hookeri* away from Auckland Islands and Campbell Island in the last 100 years has occurred at The Snares, Stewart Island and Otago (Childerhouse and Gales 1998). Cawthorn (1993) reported production of 10 pups at The Snares in 1992/93 (Cawthorn 1993), but this location was no longer considered a breeding site in 1995/96 (Gales and Fletcher 1999). Births of five single pups at Stewart Island since the 1988/89 breeding season (Childerhouse and Gales 1998; McConnell 2001) do not appear to reflect consistent breeding. These examples illustrate the ephemeral nature of breeding

in locations where the number of females is low. To date (2001), two females born at Otago have reached adulthood. Both have remained resident and have bred at Otago. Neither have displayed site-specific philopatry and Pup 1, the only locally-born female to have pupped more than once, has not displayed site fidelity. However, these female pups have remained and bred at Otago and so can be said to exhibit regional philopatry. The birth of two pups on the same beach in the 2000/01 season, and the generally gregarious nature of the females and their pups, could represent the initial stages of colonial breeding on Otago Peninsula. Not only does colonial breeding increase the chances of survival of pups (Campagna *et al.* 1992), but it may also encourage more migrant females to remain and breed (Baker 1978; Gentry 1998).

So far, all of the prerequisites for the establishment of breeding by *P. hookeri* have been fulfilled at Otago. One female has migrated to Otago and remained in the area to breed. Her offspring have also survived, remained resident, and have exhibited regional philopatry by breeding at Otago. However, our results cannot yet be taken as indicative of a sustained spread in breeding distribution because records from other locations with low numbers of females indicate that breeding can be ephemeral. Previous studies documenting expansion of the breeding range in other pinnipeds have presented rates of numerical increase (e.g., Bigg 1988; Stewart *et al.* 1994; Hofmeyr *et al.* 1997; Gales *et al.* 2000) with no detail of individual life histories. New breeding populations typically increase through colonisation by immigrants as well as through intrinsic population growth. We suggest that the isolated nature of the established breeding colonies for *P. hookeri* make their situation atypical, if not unique, as low levels of female immigration to Otago have meant that all increases in the number of breeding females at Otago have occurred through intrinsic growth. Therefore, survival of immigrant females may be paramount in the establishment of breeding colonies on the mainland of New Zealand. These females also face anthropogenic threats ashore that are absent from breeding colonies further south. We believe that continued breeding by *P. hookeri* at Otago can be facilitated by actively protecting females and their pups here, in the hope that their presence will signal the suitability of Otago as a breeding site to other immigrant females that would otherwise return to the Auckland Islands to breed.

From 1996 - 2000, the Auckland Islands squid trawl fishery was closed early each year because the MALFIRM was exceeded (Manly and Walshe 1999; Doonan 2000; Maunder *et al.* 2000). However, the founder female was born and had arrived at Otago

before any fishery closures were instigated. Therefore, we conclude that the initiation of breeding at Otago has been a serendipitous event attributable to atypical behaviour by a single female, rather than an outcome of conservation management practices at Auckland Islands.

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