SHIP-BORNE OBSERVATIONS OF NEW ZEALAND FUR SEALS ACROSS THE CONTINENTAL SHELF NEAR OTAGO PENINSULA, NEW ZEALAND

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ABSTRACT

Hawke, D.J. (1991). Ship-bourne observations of New Zealand fur seals across the continental shelf near Otago Peninsula, New Zealand. *New Zealand Natural Sciences* 18: 45-49.

Seventeen individuals of *Arctocephalus forsteri* were seen in the course of 64.75 h observations and 22 occupations of a transect crossing the continental shelf from Otago Peninsula. Abundance was highest in summer, consistent with observations at adjacent haul out sites. There were no significant differences in abundance with time of day. Abundance was greatest in the inner shelf (74.6% of sightings, corrected for observation effort) and outer shelf (25.4% of sightings) regions, with no sightings in the mid shelf region of the transect. The peak in abundance near the continental shelf break is consistent with published observations on other fur seal species.

KEYWORDS: N.Z. fur seal - *Arctocephalus forsteri* - Otago Peninsula.

INTRODUCTION

The New Zealand fur seal *Arctocephalus forsteri* (Lesson 1828) is the most abundant pinniped species in the NZ region (Crawley and Wilson 1976). It is also found in Australia (King 1983). On land, it is found mostly on rocky shores, to which it is well adapted (Beentjes 1990).

Access problems have caused pinniped research to be generally concentrated on terrestrial aspects. Direct observations of fur seals at sea are very limited (Ensor and Shaughnessy 1990). Such observations would supplement technology such as radio telemetry and time-depth recorders (TDR) in giving information on distribution at sea, social behaviour and on animals other than postpartum females. Recent studies using telemetry and TDR on postpartum females of many fur seal species (Gentry *et al.* 1986, Antonelis *et al.* 1990) have shown that fur seals typically travel directly to their feeding grounds some distance offshore. They dive principally at night, and return directly to the haul-out area having spent up to a week at sea. Loughlin *et al.* (1987) showed that female northern fur seals (*Callorhinus ursinus*) spend at least half of their time at sea.

There are no published studies dealing with *A. forsteri* at sea. The Otago region of southern NZ is well suited to field studies of this type because of its accessibility from Dunedin city and the year-round presence of *A. forsteri* along the Otago coast (Crawley and Wilson 1976, Armstrong 1988). This paper reports incidental ship-borne observations made during oceanographic cruises from 1986 to 1988.

STUDY AREA AND METHODS

The hydrology of Otago shelf waters has been described by Jillett (1969) and Hawke (1989). The Subtropical Convergence (STC) is found as a surface feature in the region of the continental shelf break. Along the Otago coast the shelf break occurs at around 150 m depth and 15-35 km offshore. Waters inshore of the STC are of subtropical origin with a surface band of neritic water close to the coast. Relatively cold subantarctic waters are found immediately offshore of the STC.

Observations from rv "Munida" were recorded during nine cruises to and along a transect running E-SE from Pipikaretu Point to within

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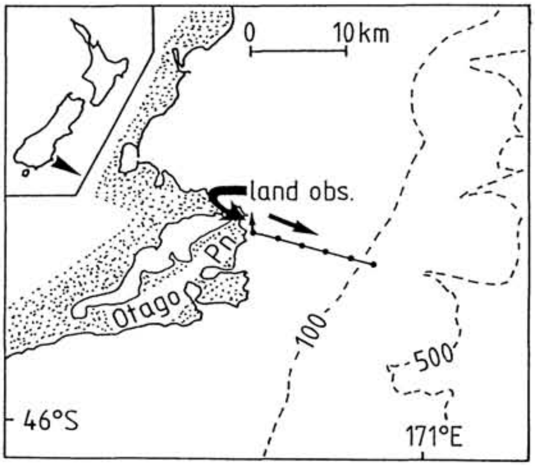

Figure 1. The study area, showing the transect (heavy line, with stations marked as circles), route travelled (arrows), and bathymetry (dashed lines; depth in metres). The site of the land observations is also shown. Inset: the location of the study area on the South Island east coast.

2.7 km of the shelf break (Fig. 1) from October 1986 to January 1988 (Table 1). These resulted in the transect being travelled 22 times.

While travelling between transect stations, observations were made from the vessel wheelhouse. Being a small vessel (14 m overall length), visibility forward and to each side could be easily maintained. Under typical sea and weather conditions, seals could be seen up to a distance of 50-100 m. While stationary, a general lookout was maintained from the work area on the afterdeck. The degree of watchfulness was approximately constant throughout the study period. All voyages were made in good conditions with a swell height of less than 2 m. While there was considerable variability in sea conditions, weather and visibility between voyages, there was no discernable seasonality to the variability.

Seal location was determined relative to the oceanographic stations shown in Fig. 1. Positions of the observations made while travelling were calculated from the time of observation relative to the times at adjacent stations. Position fixing of stations was by radar and depth soundings.

Two species of otariid seal are established on Otago Peninsula; *A. forsteri*, and Hooker's sea lion (*Phocarctos hookeri*) (Hawke 1986). Most of the seals seen were relatively inactive, allowing identification based on the more pointed snout of *A. forsteri*. Seventy percent (17 sightings) of seals sighted were positively identified as *A. forsteri*. Less than 5% (one sighting) were positively identified as *P. hookeri*. The remaining six seals could not be positively identified.

The raw data were grouped into three month intervals to identify seasonal trends, three hour time intervals to identify diurnal trends, and 5.4 km distance intervals to identify spatial distribution. Statistical analysis was by *t*-test for seasonal and diurnal data, and Chi-squared test for spatial distribution. For the seasonal analysis, the intervals chosen correspond to the land seasons. Using this classification, summer corresponds to December to February, autumn corresponds to March to May, etc. In Otago Peninsula waters, maximum and minimum water temperatures occur in February and August respectively (Jillett 1969). The period of maximum nutrient depletion associated with the spring bloom occurs in September or October (Hawke 1988). Land and maritime seasons therefore approximately match.

A critical point in assessing the reliability of shipborne observations is the reaction of the species under observation to the presence of the ship. I found *A. forsteri* to be indifferent to the vessel. Individuals directly in the vessel path moved to avoid being run down. Individuals to the side either ignored the vessel or only briefly elevated their heads. On one occasion only, an individual swam slowly around the stationary vessel while we were retrieving equipment. It did not follow when

Table 1. Distribution of observation effort (hours) by month and year.

Year	J	F	M	A	M	J	J	A	S	O	N	D
1986	-	-	-	-	-	-	-	-	-	12.5	-	-
1987	7.8	3.5	12.0	-	-	7.8	-	1.8	-	3.5	12.5	-
1988	3.5	-	-	-	-	-	-	-	-	-	-	-

the vessel moved off.

Land observations to assess the abundance of seals on the coast adjacent to the transect were made at two locations on opposite sides of a 2 km wide, eastward facing bay at the shoreward end of the transect (Fig. 1). Observations were made along the southern side of the bay leading to Pipikaretu Point from January to July 1989. A smaller set of observations, covering April to July 1989, were made near Penguin Place on the northern side of the bay. The two locations combine a wide range of substrates, including sandy beach, boulder beach, and rock platforms. Being on opposite sides of an eastward-facing bay, the two locations have differing but complementary exposure to sun. Counts were made approximately monthly. Weekdays were chosen to reduce the possibility of human interference. All counts were made in the early to mid afternoon, when haul out density is highest (Crawley 1972), using 9 x 25 binoculars.

RESULTS AND DISCUSSION

Seventeen positively identified *A. forsteri* were seen in 64.75 hours of observations. Of the 17, 11 were of a single animals. The remaining six animals were observed as three pairs. No large groups of fur seals, as reported by Ensor and Shaughnessy (1990) for *A. gazella* and *A. tropicalis*, were seen. The raw data, and associated observational effort, are shown on the respective figures.

A. forsteri were seen significantly more often in summer than in each of the other seasons (t = 0.10, df = 21, $P < 0.05$). Sightings in autumn, winter and spring were closely similar (Fig. 2). Counts at the nearby hauling out area showed the same general trend, with numbers decreasing from the summer months into winter (Fig. 3). Based on one data point, abundance at Pipikaretu Point peaks in late summer. In other species of fur seal, it appears that individuals swim directly from the haul out areas to deep water at or beyond the shelf break (Gentry *et al.* 1986). Comparing the trends of Figs. 2 & 3 shows that observations at sea follow the same trends as haul out abundances at the shoreward end of the transect, as one might expect.

The distribution of sightings with time of day over the entire transect was comparatively even

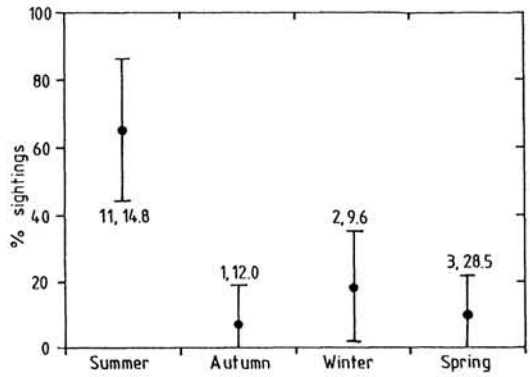

Figure 2. Fraction of total sightings (corrected for observation effort), as a function of season. The error bars show the 95% confidence intervals calculated by t-test. Raw data are shown for each point as "number of *A. forsteri*, hours of observation".

(Fig. 4). The lack of sightings in the 2000-2300 h time block could be an artifact of a low observation effort. The decrease in sightings between 1100 and 1400 h is not significant (P = 0.11).

The distribution of sightings across the continental shelf show a bimodal distribution (Fig. 5), with maximum abundances over the inner shelf and over the outer shelf. No *A. forsteri* were seen in the mid shelf region. A Chi-square test showed that the observed distribution differed from the expected values under the null hypothesis that seals are randomly distributed with distance offshore (X^2 = 13.4, df = 2, $P < 0.005$). The high inshore abundance could be related to the landward end of the transect near the haulout acting as

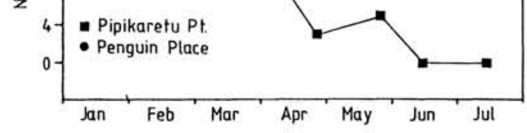

Figure 3. Haul out abundance at two locations in 1989 immediately north of the shoreward end of the transect shown in Fig. 1.

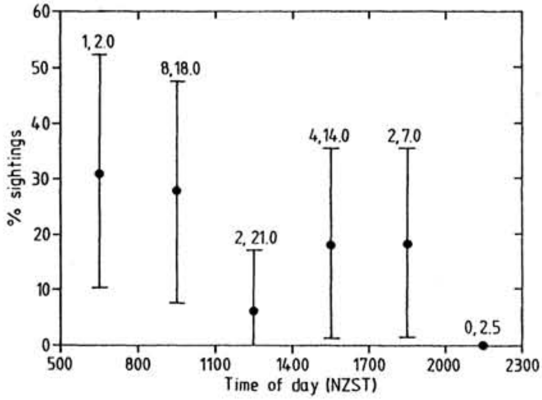

Figure 4. Fraction of total sightings (corrected for observation effort), as a function of time of day. The error bars show the 95% confidence intervals calculated by *t*-test. Raw data for each point are shown as "number of *A. forsteri*, hours of observation".

a hub through which seals radiate out. It is also consistent with thermoregulatory behaviour, and possibly feeding. However, *A. forsteri* diet is not well known.

Gentry *et al.* (1986) showed that many fur seal species (*C. ursinus*, *A. gazella*, *A australis* and *A. galapagoensis*) travel some distance offshore to feed, typically to the region of the shelf break. Absences from haul outs range from a few days to a week. On the basis of TDR results, these authors argued that fur seals swim directly between this region and the hauling ground. Most diving is done at night, so that significant time is spent at the surface during the day in the locality of feeding grounds (Gentry *et al.* 1986; Loughlin *et al.* 1987; Antonelis *et al.* 1990).

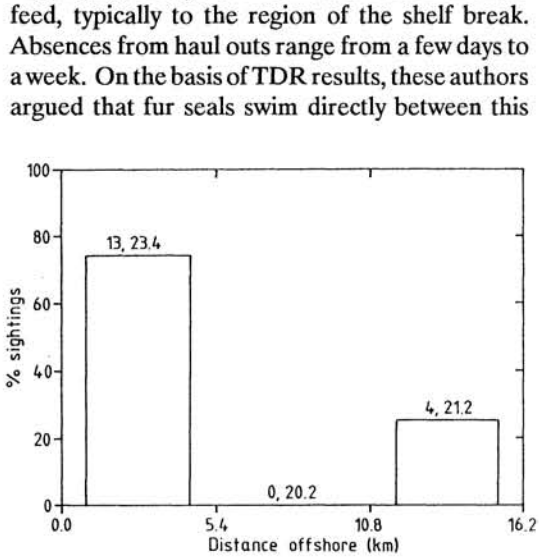

Figure 5. Fraction of total sightings (corrected for observation effort), as a function of distance offshore. Raw data for each point are shown as "number of *A. forsteri*, hours of observation".

Although there are no telemetry and TDR data for *A. forsteri*, the peak in sightings near the shelf break (Fig. 5) is consistent with results found in other fur seals (Gentry *et al.* 1986). The lack of sightings in the midshelf region is consistent with rapid transit between hauling grounds and a feeding area in the region of the shelf break. They also refect a stay near the shelf break that is long relative to the transit time. However, further information is required before an unequivocal parallel can be drawn between behaviour at sea of *A. forsteri* and other fur seals.

SUMMARY

Surveillance for *A. forsteri* was carried out on nine separate days along a transect crossing the continental shelf from Otago Peninsula. Seventeen sightings of *A. forsteri* were made in the course of 64.75 h of observations and 22 occupations of the transect. The results showed that abundance was highest in summer, consistent with abundance at adjacent haul out sights. There were no significant differences in abundance with time of day. Across the shelf, abundance was greatest adjacent to the coast. There was also a smaller peak in abundance at the offshore end of the transect close to the continental shelf break. The spatial distribution of *A. forsteri* reported here is therefore consistent with published observations on other fur seal species.

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REFERENCES

Antonelis, G.A., Stewart, B.S. & Perryman, W.F. (1990). Foraging characteristics of female northern fur seals (*Callorhinus ursinus*) and California sea lions (*Zalophus californianus*).

Canadian Journal of Zoology 68: 150-158.

Armstrong, M.R. (1988). Census and some behavioural and thermoregulatory studies of the New Zealand fur seal, *Arctocephalus forsteri* (Lesson, 1828), on the Otago Peninsula, New Zealand. M.Sc. Thesis, University of Otago, New Zealand.

Beentjes, M.P. (1990). Comparative terrestrial locomotion of the Hooker's sea lion (*Phocarctos hookeri*) and the New Zealand fur seal (*Arctocephalus forsteri*): evolutionary and ecological implications. *Zoological Journal of the Linnean Society* 98: 307-325.

Crawley, M.C. (1972). Distribution and abundance of New Zealand fur seals on the Snares Islands, New Zealand. *New Zealand Journal of Marine and Freshwater Research* 6: 115-126.

Crawley, M.C. & Wilson, G.J. (1976). The natural history and behaviour of the New Zealand fur seal (*Arctocephalus forsteri*). *Tuatara* 22: 1-29.

Ensor, P.H. & Shaughnessy, P.D. (1990). Fur seals over the Kerguelen Plateau and elsewhere in the Southern Ocean. *Polar Biology* 10: 481-483.

Gentry, R.L., Costa, D.P., Croxall, J.P., David, J.H.M., Davis, R.W., Kooyman, G.L., Majlif, P., McCann, T.S. & Trillmich, F. (1986). Synthesis and conclusions. In: *Fur Seals, Maternal Strategies on Land and at Sea* (ed. R.L. Gentry & G.L. Kooyman). Princeton University Press, Princeton, U.S.A., pp. 220-264.

Hawke, D.J. (1986). Observations of Hooker's sea lion (*Phocarctos hookeri*) at a hauling ground on Otago Peninsula, New Zealand. *New Zealand Journal of Marine and Freshwater Research* 20: 333-337.

Hawke, D.J. (1988). Aspects of the marine chemistry of phosphate. Ph.D. Thesis, University of Otago, New Zealand, pp. 103-105.

Hawke, D.J. (1989). Hydrology and near-surface nutrient distribution along the South Otago continental shelf, New Zealand, in summer and winter 1986. *New Zealand Journal of Marine and Freshwater Research* 23: 411-420.

Jillett, J.B. (1969). Seasonal hydrology of waters off the Otago Peninsula, south-eastern New Zealand. *New Zealand Journal of Marine and Freshwater Research* 3: 349-375.

King, J.E. (1983). *Seals of the World*. Cornell University Press, Ithaca, U.S.A., pp. 57-60.

Loughlin, T.R., Bengston, J.L. & Merrick, R.L. (1987). Characteristics of feeding trips of female northern fur seals. *Canadian Journal of Zoology* 65: 2079-2084.