

# Assessing seasonal differences in Hooker's sea lion locations

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# Assessing seasonal differences in Hooker's sea lion locations

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## ABSTRACT

To obtain more information about the movements of Hooker's sea lion (*Phocarctos hookeri*) groups from their breeding grounds in the Auckland Islands, tagged individuals have been monitored by satellite; this report summarises the analysis of the seasonal differences shown in their locations. Location fixes (specification of latitude and longitude) were obtained for five periods: during austral summer in 1995/96, 1996/97 and 1997/98, and during austral winter in 1996 and 1997. There is clear evidence of an overall difference in mean location between summer and winter during the first 2 years, but there is no evidence that this difference depends on the year. There is no evidence that the mean location in summer 97/98 differed from that for the other four periods.

Keywords: Hooker's sea lion, *Phocarctos hookeri*, satellite tracking, seasonal location.

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# 1. Introduction

The New Zealand sea lion, or Hooker's sea lion *Phocarctos hookeri*, is one of the world's rarest pinnipeds, with IUCN rating of Vulnerable (McGonigal & Woodworth 2001). It breeds within a highly localised region, principally on Enderby and Dundas Islands in the Auckland Islands, and individuals make foraging or dispersal trips over what is believed to be a fairly restricted area (Childerhouse & Gales 1998). To establish more information about these movements, tagged individuals have been monitored by satellite, and this report summarises the analysis of the seasonal differences shown in locations of Hooker's sea lions.

# 2. Methods

Results were obtained from satellite tracking of 20 tagged individuals between 1995/96 and 1997/98. Location fixes (specification of latitude and longitude) were obtained for five periods: during austral summer in 1995/96, 1996/97, and 1997/98, and during austral winter in 1996 and 1997. All the fixes for any one individual came from one period, and these were obtained from a number of *trips*, with each trip containing between 5 and 49 fixes.

As the fixes per trip cannot reliably be regarded as independent, we first reduced the data by calculating the mean latitude and longitude per trip. Inspection of these means indicated that trip 1 for individual E35 had a mean location (lat. 51.72°S, long. 168.26°E) that was completely different from all the others. This trip was therefore removed from all subsequent analyses.

In order to compare locations between seasons and years, we used multivariate analysis of variance (MANOVA). For this analysis we need to consider the sea lion as the sampling unit. We have therefore further reduced the data by calculating for each sea lion the mean of all latitude and longitude trip means for that individual. Note that in calculating this mean per sea lion we did not weight the trips by the number of fixes, as the latter cannot be regarded as independent. In the MANOVA, each observation was weighted by the number of trips observed for that sea lion. Although the trips may not be exactly independent, this weighting should approximately reflect the different levels of precision associated with each mean.

Before presenting the results of the analysis, we consider two assumptions underlying the MANOVA:

1. The spatial variation between sea lions (i.e. between their mean locations) is assumed to be approximately the same for all year-season combinations. This was tested using a randomisation-based method. The resulting *P*-value was 0.40, suggesting that there is no evidence for this assumption being wrong.

2. The spatial variation between sea lions is assumed to be approximately bivariate normal, for all year-season combinations. Plots of the mean locations suggest that this assumption is reasonable. Note that the impact of this normality assumption being wrong is less severe than for the first assumption of error homogeneity.

### 3. Results

Table 1 shows the mean latitude and longitude for each sea lion, as well as the number of trips per sea lion.

Figure 1 shows the 95% confidence regions for each year-season combination. They show the area within which we are almost sure the mean location (over all sea lions) for that year-season is located.

There is clear evidence of an overall difference in mean location between the five periods ( $P = 0.009$ ).

TABLE 1. MEAN LOCATION FOR EACH SEA LION AND THE NUMBER OF TRIPS PER MEAN.

PERIOD	LATITUDE <sup>1</sup> °S	LONGITUDE <sup>1</sup> °E	NUMBER OF TRIPS
Summer 95/96	50.416	166.248	1
	50.406	166.113	4
	50.512	166.424	2
	50.403	166.128	7
	50.597	165.809	7
Winter 96	49.960	166.947	8
	50.276	167.057	10
	50.450	167.329	11
Summer 96/97	50.933	167.252	4
	50.552	167.219	6
	50.637	165.783	6
Winter 97	50.128	167.211	7
	50.432	166.676	12
	49.764	166.430	14
	49.993	167.363	9
Summer 97/98	50.245	166.100	4
	50.836	166.392	3
	50.154	166.119	2
	49.926	166.522	3
	50.240	166.167	6

<sup>1</sup>Latitude and longitude are shown with an accuracy of thousandths of degrees.

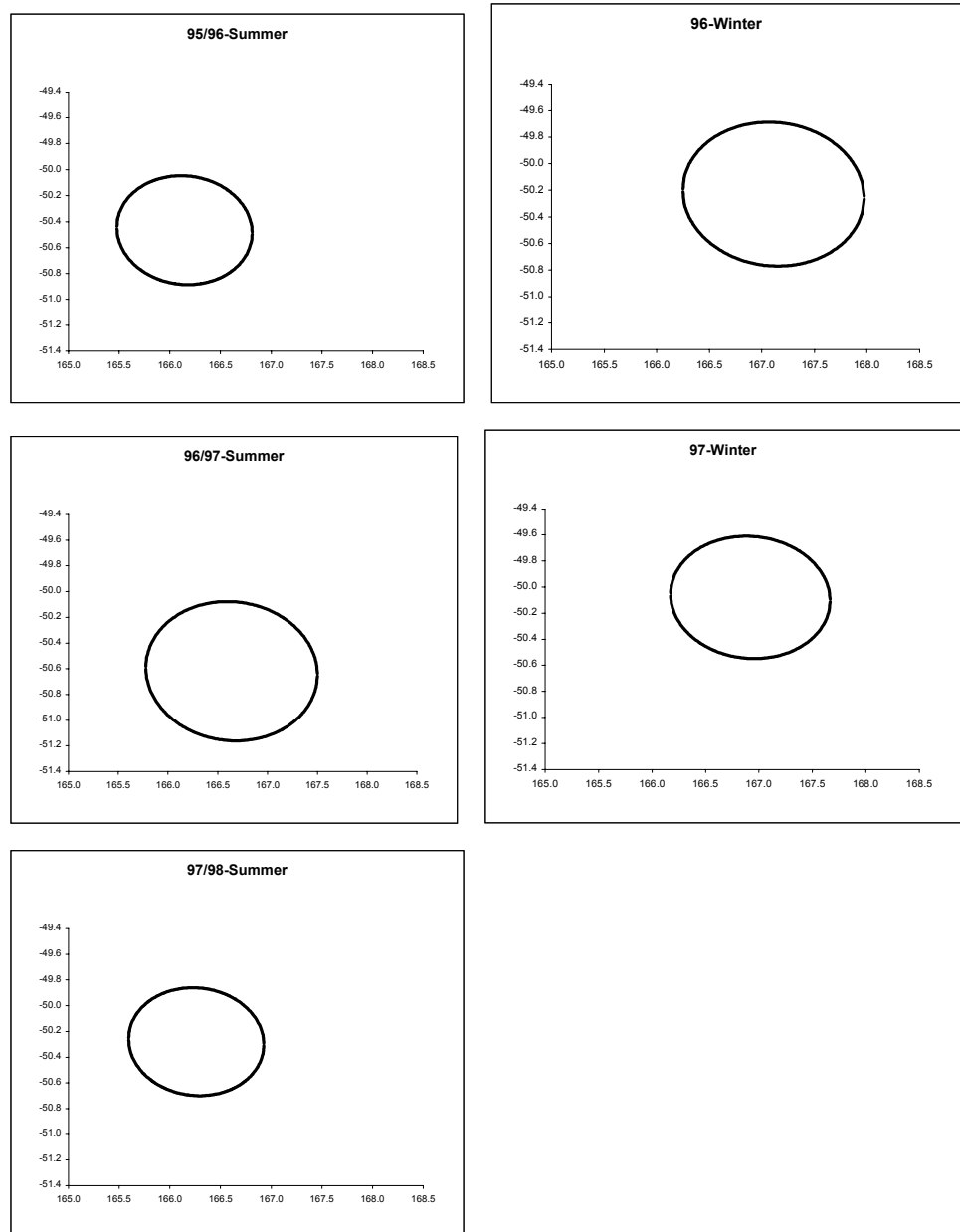


Figure 1. Confidence regions for mean location of sea lions in the five periods in the study. Positive values of longitude ( $x$ -axis) represent °E; negative values of latitude ( $y$ -axis) represent °S.

During the 95/96 and 96/97 periods, there is clear evidence of an overall difference in mean location between summer and winter ( $P = 0.002$ ). There is no evidence that this difference depends on the year ( $P = 0.128$ ).

There is no evidence that the mean location in summer 97/98 differed from that for the other four periods.

## 4. Conclusions

Overall, this analysis suggests that there are clear differences in distribution of Hooker's sea lions between summer and winter, but not between years, and that the seasonal difference is consistent for the two full years in this study. The mean location for the sea lions tracked was to the north-west of the Auckland Islands, around lat. 50-51°S and long. 165.5-167°E (summer) and lat. 49.5-50.5°S and long. 166-168°E (winter).

## 5. References

- Childerhouse, S.; Gales, N. 1998: Historical and modern distribution and abundance of the New Zealand sea lion *Phocarctos hookeri*. *New Zealand Journal of Zoology* 25: 1-16.
- McGonigal, D.; Woodworth, L. 2001: Antarctica: The complete story. Random House, Auckland. 680 p.