

Distribution, abundance and pup production of the New Zealand fur seal (*Arctocephalus forsteri* Lesson) at the Bounty Islands

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Abstract

The distribution, population size and pup production of New Zealand fur seals at the Bounty Islands (47°45'8, 179°03'E) were investigated using aerial photographs taken on 7 January 1994. Fur seals haul out on virtually all islands and stacks, and use over 50% of the total land area. A total of 6,214 seals (excluding new-born pups) was counted from vertical photographs covering the entire island group, and annual pup production was estimated as about 4,380, from sample counts using low-level oblique photographs. The size of the Bounty Islands' fur seal population (i.e., all seals breeding or born there, including pups and non-breeders, but excluding temporary non-breeding immigrants) is estimated at approximately 21,500. A comparison with earlier counts and estimates suggests that numbers of fur seals at the Bounty Islands are still increasing but that population growth is slowing.

1. Introduction

The New Zealand fur seal (*Arctocephalus forsteri*) inhabits the New Zealand region and the southern coasts of Australia. Its numbers and breeding range are now expanding rapidly in both countries (Taylor 1982, 1992, Dix 1993, Shaughnessy *et al.* 1994, Lalas and Harcourt 1995, Taylor *et al.* in press), following centuries of exploitation and more recent legal protection. However, the size and dynamics of the current New Zealand population are poorly known (Taylor *et al.* in press). Up-to-date population counts and estimates are still needed from many parts of New Zealand. The size of a fur seal population is best estimated from the numbers of young pups in breeding rookeries, as this age group is easily recognised and confined to shore (Crawley and Brown 1971, Taylor 1982). Counts of other seals give at best only a very rough index of relative abundance (Alterio *et al.* 1991).

The numbers of fur seals at the Bounty Islands (47°45'8, 179°03'E) were last assessed 13 years ago (Taylor 1982). The Bounty Islands consist of 20 small granite islands and 5 wave-swept rocks. All are low-lying and devoid of land vegetation, except green algae. Sealing activities since the islands were discovered in 1788, and past changes in the abundance of seals were summarised by Taylor (1982). He found that aerial photography was a practical method for monitoring fur seal numbers at the Bounty Islands, where there are very few overhead obstructions and the animals show up clearly on the smooth granite rock. He considered the method was free of many of the density-dependent errors that handicap ground counts, and especially suitable for monitoring rapidly increasing populations.

The present study uses findings from a visit by ship in March 1985 and aerial photographic surveys in December 1983 and January 1994 to investigate fur seal distribution and numbers at the Bounty Islands.

2. Methods

2.1 GROUND COUNTS

I landed on Depot and Penguin Islands from HMNZS Monowai on 7 and 9 March 1985 to carry out ground control for a fur seal census to be based on concurrent aerial photography. Seals hauled out on parts of Depot and Penguin Islands were sampled to measure the ratio of pups to others ashore, and to estimate the percentage of animals that would be hidden from aerial photography by boulders and overhangs. In addition, counts were made from these two islands, and from a Wasp helicopter, of the numbers of seals on several smaller adjacent islands and on islets in the Centre Group.

2.2 AERIAL PHOTOGRAPHY

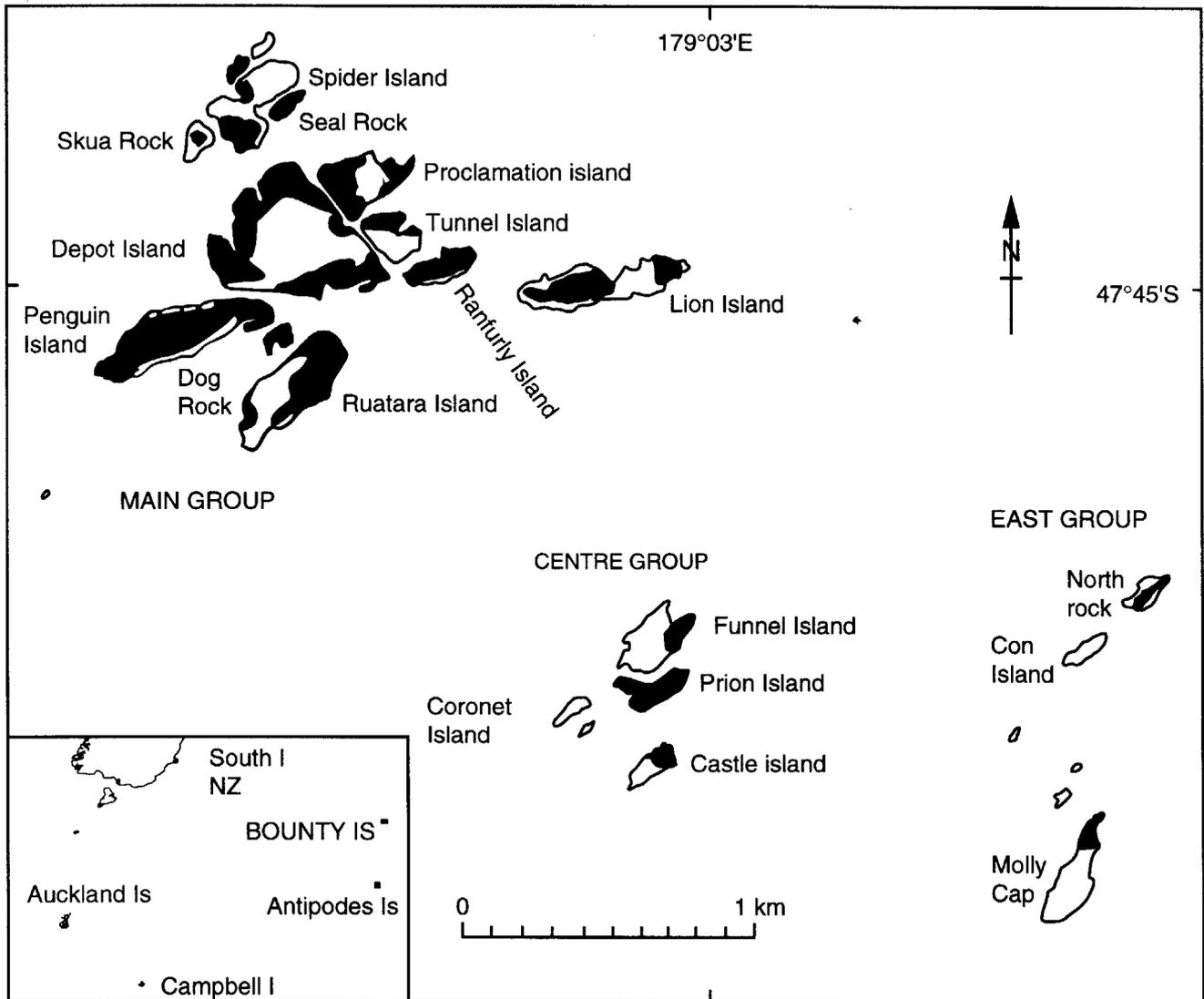
On 5 December 1983, monochrome photographs of the Bounty Islands were taken vertically from a RNZAF Orion with a fixed 5" x 5" aerial camera from 800 ft a.s.l. These photographs covered nearly all areas used by seals. On 7 and 9 March 1985 near-vertical monochrome photographs covering most of the Bounty Islands were taken by staff of the Department of Lands and Survey from a RNZN Wasp helicopter flying at altitudes of 600-1600 ft. Unfortunately, the negatives and prints of the 1985 exposures were misplaced in Wellington when the Department of Lands and Survey was disbanded in 1987, and I have been unable to trace them. Vertical monochrome photographs of all of the Bounty Islands were again taken by a RNZAF Orion on 7 January 1994 from altitudes of 1200-3000 ft. On the same flight, a 35 mm camera with 100 mm lens was used to take oblique colour photographs from 300 ft a.s.l. of parts of breeding rookeries and haulouts on many of the islands.

Prints of the 1983 and 1994 photographs were examined and identified as to their precise location and coverage. The areas of the islands used by fur seals as breeding rookeries and hauling grounds were mapped (Fig. 1).

2.3 ESTIMATION OF NUMBERS

Selected monochrome exposures were enlarged to 250 x 250 mm size to give complete coverage of all sites used by seals. The numbers of seals ashore, excluding new-born pups, were counted under a magnifying lens and totalled for each islet or haulout area. Some of the 1994 verticals were enlarged from negatives taken from up to 3000 ft with a resultant loss of detail. To check the effect of this on seal counts, areas covered by good-quality low-level obliques were outlined on some of these "high-altitude" prints and seals (one year or more old) were counted on each.

FIGURE 1 THE BOUNTY ISLANDS, SHOWING (BLACK) THE DISTRIBUTION OF HAULED-OUT FUR SEALS ON 7 JANUARY 1994.



All suitable oblique exposures were enlarged to 200 x 250 mm, and used to count the ratio of new-born pups to older seals ashore at various locations. This ratio was then used to estimate the number of pups produced in 1993-94 by relating it to the total number of other seals found at the Bounty Islands on the same day.

The total number of seals in a population can be estimated by multiplying pup numbers by a value allowing for other age groups. The actual population:pup ratio can vary with changes in life history parameters and depending on whether the population is increasing, stable or decreasing (Harwood and Prime 1978, Wickens and Shelton 1992). The present Bounty Islands population was estimated by multiplying the number of pups produced in 1993-94 by 4.9. This multiplier - previously used for New Zealand fur seals at the Bounty Islands (Taylor 1982), in South and Western Australia (Shaughnessy *et al.* 1994), and in Nelson-northern Marlborough, New Zealand (Taylor *et al.* in press) - is based on a rapidly expanding population, and on factors such as age of first breeding,

pregnancy rate, age-related mortality, and longevity - all estimated from other studies of *Arctocephalus* species (Bonner 1958, Crawley and Brown 1971, Payne 1977, 1978, Mattlin 1978a).

3. Results

3.1 DISTRIBUTION

Fur seals are widely distributed over the Bounty Islands, being present on all islands and islets - except wave-washed rocks (Fig. 1). Over 50% of the islands' total surface area is used by seals. In 1983 and 1994, as in 1980 (Taylor 1982), fur seals were found in greatest numbers on Penguin, Depot and Proclamation Islands of the Main Group. In all years less than 6% were on the Centre Group and 1% on the East Group. The area of the Bounty Islands used by seals for hauling out and breeding has increased by about 30% since 1980.

3.2 SEAL COUNTS

Ground counts and observations on six islands and islets during 7-9 March 1985 showed that numbers ashore during March are somewhat lower than during the breeding season, and that less than 2% of all seals ashore at the Bounty Islands would have been hidden from vertical aerial photography. Of 304 seals sampled at 3 localities on Depot Island, 126 (41%) were pups. However, on Penguin Island, 841 (72%) of 1165 seals checked were pups. Field estimates suggested that there were about 1,565 seals on Penguin Island - including 1,000 pups which were mostly near the sheltered pools at the eastern end. At this stage of the breeding season, it is likely that many of these pups had swum from other nearby islands.

The vertical photographs taken from 800 ft a.s.l. of all seal haulouts on the Bounty Islands on 5 December 1983 gave a total of about 7271 seals ashore, excluding new-born pups. Similar counts from the aerial photographs taken on 7 January 1994 gave a minimum of 5976. The comparison of counts from areas covered by low-level obliques and from the same areas delineated on higher altitude verticals (from 1200-3000 ft a.s.l.) showed that counts from some verticals were underestimating seals ashore by about 7%. By applying this factor to the relevant counts, the January 1994 total was corrected to 6214 fur seals one year or more old.

Table 1 summarises all counts of New Zealand fur seals carried out at the Bounty Islands during the last 25 years. Those for 1974-1980 are from Taylor (1982), others result from the present study.

3.3 ESTIMATE OF TOTAL POPULATION

Pups amounted to 37% of all seals counted in the low-level oblique photographs taken on five different islands on 7 January 1994 (Table 2). Annual pup production was roughly estimated as about 4380 by relating the 37:63 ratio of young pups to other seals to the 6214 seals, one year or more old, ashore on the same date - and adding 20% for pups missed or already dead (Mattlin 1978, Taylor 1982).

Overall population size (i.e., the extant population breeding or born at the Bounty Islands, including pups and non-breeders but excluding temporary non-breeding immigrants) was estimated - by multiplying the number of pups by 4.9 (Taylor 1982) - as roughly 21,500.

4. Discussion and conclusions

Aerial photography is the most practical method for monitoring fur seal numbers at the Bounty Islands, where the animals show up clearly on the smooth granite substrate and less than 2% will be hidden by rocks or overhangs (Taylor 1982, pers. obs.). The 1994 photographs were taken from a greater altitude than optimum, resulting in some loss of clarity and accuracy of counting. Nevertheless, they were adequate to allow major trends in the fur seal population to be detected. Future aerial surveys should be carried out during January with fixed wing aircraft from a maximum altitude of 1000 ft, or more ideally from a ship-based helicopter at 300-500 ft a.s.l.

The potential sources of error in the present calculations of 4,380 pups and 21,500 seals in total, are similar to those given for the earlier estimate of the Bounty Island's seal population derived from aerial photographs (Taylor 1982). In particular, the value (37%) for the percentage of pups in the population ashore on 7 January 1994 had to be based on a sample of only 10% of all seals hauled out on the islands. If calculations are made using the maximum value (43%) found on Funnel Island then the estimated total fur seal population of the Bounty Islands rises to over 27,500. Conversely, the lowest value (35%) found on Depot Island gives a population estimate of about 19,700 seals.

The Bounty Islands population with an estimated annual pup production of 4,380 represents by far the largest fur seal concentration recorded in New Zealand waters. By comparison, the Open Bay Islands produce about 1,500 pups annually (Crawley and Brown 1971, Mattlin 1978b, Hugh Best pers. comm.), the Cascade, Wekakura and combined Otago Peninsula rookeries about 1,000 each (Anderson 1990, Hugh Best pers. comm., Lalas and Harcourt 1995), and all four Nelson-northern Marlborough rookeries a total of around 500 (Taylor *et al* in press).

A census of fur seals at the Bounty Islands in 1980/81 found about 3,280 pups, indicating that the total population was then around 16,600 (Taylor 1982).

TABLE 1. COUNTS OF NEW ZEALAND FUR SEALS HAULED OUT ON THE BOUNTY ISLANDS (✓ SEALS ASHORE BUT PHOTOGRAPHIC COVERAGE INCOMPLETE; -, NO DATA). DECEMBER AND JANUARY COUNTS EXCLUDE NEW-BORN PUPS.

	24 MAY 1974	7 NOV 1978	29 NOV 1978	29 DEC 1980	5 DEC 1983	7/9 MAR 1985	7 JAN 1994
Nth Spider stacks	-	0	-	-	20	-	40
Spider I	✓	110	50	-	290	207	443
Seal Rock	-	50	-	-	305	180	215
Skua Rock	-	10	-	-	-	2	13
Depot I	✓	605	✓	✓	2119	✓	1297
Proclamation I	✓	590	280	✓	980	✓	519
Tunnel I	-	90	✓	✓	255	✓	296
Penguin I	470	710	520	1760	1878	1565	1738
Dog Rock	-	0	-	✓	12	42	51
Ruatara I	-	190	90	362	372	✓	392
Ranfurlly I	-	70	✓	✓	307	✓	386
Lion I	✓	155	✓	-	446	✓	460
Funnel I	14	30	-	-	68	✓	97
Prion I	14	35	-	-	211	60	237
Coronet I	-	0	-	-	-	0	3
Castle I	-	0	-	-	0	0	9
North Rock	10	10	-	-	8	-	6
Con I	-	0	-	-	0	-	0
Mollycap	-	5	-	-	-	-	12
Totals ashore		2660			7271		6214

TABLE 2. TOTAL NUMBERS OF SEALS AND PERCENTAGE OF NEW-BORN PUPS DETECTED ON LARGE-SCALE OBLIQUE PHOTOGRAPHS TAKEN AT 5 ISLANDS IN THE BOUNTY ISLANDS GROUP ON 7 JANUARY 1994.

	TOTAL SEALS	PUPS	
		n	%
Spider Island	188	67	36
Depot Island	256	89	35
Penguin Island	232	94	41
Ruatara Island	256	96	38
Funnel Island	63	27	43
Totals	995	373	Mean 37

Comparison with the 1993/94 estimates of 4,380 pups and 21,500 seals in total suggests that the numbers of Bounty Islands fur seals are still increasing but that population growth is slowing - having averaged 4.9% per year from 1903 to 1980 (Taylor 1982), and about 2.1% since.

The winter deepwater trawl fishery that developed for Southern Blue Whiting (*Micromesistius australis*) around the Bounty Islands during the 1990s has been responsible for the deaths of significant numbers of fur seals which have drowned in the trawl nets (Table 3). When the main spawning aggregations of Southern Blue Whiting are located close to the Bounty Islands, as occurred in 1994, fishing vessels operate within easy foraging range of the seal colony. Multiple captures of seals in a single trawl are not uncommon (Mike Donoghue pers. comm.).

More than half of the Bounty Islands' surface is now used by seals. In the 13 years since 1980, the area occupied by seals has increased at about the same rate (30%) as total pup production (33%). Some breeding rookeries have increased more rapidly than others. On heavily populated Penguin Island, the estimated numbers of pups have increased 54% - from 863 in 1980/81 to 1,225 in 1993/94. However, it seems that some breeding sites on Penguin and Depot Islands are now approaching their carrying capacity. A comparison of photographs taken in 1980 and 1994 indicates that numbers of pups in some of the most favoured sites have increased by only about 15%.

The growth in the fur seal population and the increasing area used by seals must be influencing other biota on the Bounty Islands. During the past 20 years, rapidly increasing fur seal numbers have caused widespread devastation of vegetation on Signy Island, South Orkney Islands (Smith 1988, 1994), and the displacement of endangered seabirds on islands off the coast of Namibia (Crawford *et al.* 1989). Although there is no vegetation to be destroyed at the Bounty Islands, competition for space with nesting seabirds - particularly the

TABLE 3 REPORTED BYCATCH OF FUR SEALS IN THE SOUTHERN BLUE WHITING FISHERIES 1993-95. FIGURES BASED ON CAPTURES REPORTED BY TELEX/FAX TO FISHERIES COMMUNICATIONS CENTRE (OBS, CAPTURES WITNESSED BY MAF FISHERIES OBSERVERS; NON-OBS, NO MAF OBSERVERS ON BOARD).

	REPORTED CAPTURES			SEX			Dead	Alive
	Obs	Non-Obs	Total	M	F	?		
1993	5G	20	7G	24	G	4G	75	1
1994	75	88	133	GG	2G	^f 41	130	3
1995	35	4	39	G	9	24	37	2

destruction of nests of Salvin's mollymawks (*Diomedea cauta salvini*) and erect-crested penguins (*Eudyptes pachyrhynchus sclateri*) - will increasingly occur. The best place to check for such effects is Penguin Island, where high numbers of seals have ready access to all parts of the island, and a total of 218 mollymawk nests were found during a ground count on 9 March 1985 (pers. obs.).

5. Recommendations

It is important that the Bounty Islands' fur seal population be reassessed by aerial photography, at the first opportunity when a ship-based helicopter is available during January. Thereafter, similar surveys should be repeated at 10 year intervals.

6. Acknowledgements

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