POPULATION DEMOGRAPHICS OF NEW ZEALAND FUR SEALS (*ARCTOCEPHALUS FORSTERI*)

Submitted by

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STATEMENT OF AUTHORSHIP

Except where reference is made in the text of the thesis, this thesis contains no material published elsewhere or extracted in whole or in part from a thesis submitted for the award of any other degree or diploma.

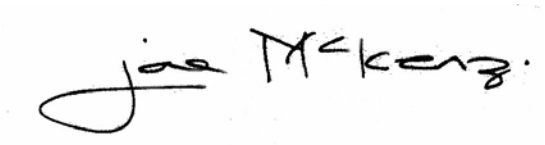
No other person's work has been used without due acknowledgement in the main text of the thesis.

The thesis has not been submitted for the award of any degree or diploma in any other tertiary institution.

This thesis is presented as a series of published or submitted papers. Although I did the significant aspects of analysis and interpretation of the results, the following people are co-authors of some of these papers because they assisted in the pursuit of the research or preparation of the thesis as described below:

B Page, A Morrissey, R McIntosh, SD Goldsworthy, A Baylis, N Calvert, M Berris, D Dowie, PD Shaughnessy, LJ Parry and many others assisted with field and laboratory work. SD Goldsworthy and MA Hindell supervised this project and received grants that funded part of this research. I offered coauthorship on papers to the people who helped considerably on this project.

All research procedures reported in the thesis were approved by the La Trobe University Animal Ethics Committee and the South Australian Department for Environment and Heritage Animal Ethics Committee.



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PUBLICATIONS

The following peer-reviewed papers resulted from work completed during candidature:

McKenzie, J., Parry, L.J., Page, B., and Goldsworthy, S.D. (2005) Estimation of pregnancy rates and reproductive failure in New Zealand fur seals (*Arctocephalus forsteri*). *Journal of Mammalogy*, 86, 1237-1246.

McKenzie, J., Page, B., Shaughnessy, P.D., and Hindell, M.A. (*in press*) Age and reproductive maturity of New Zealand fur seals (*Arctocephalus forsteri*), in southern Australia. *Journal of Mammalogy.*

McKenzie, J., Page, B. Goldsworthy, S.D., and Hindell, M.A. (*in press*) Growth strategies of New Zealand fur seals (*Arctocephalus forsteri*), in southern Australia. *Journal of Zoology (London).*

McKenzie, J., Page, B. Goldsworthy, S.D., and Hindell, M.A. (*in review*). Behavioural responses of New Zealand fur seals (*Arctocephalus forsteri*) to darting and the effectiveness of midazolam and tiletamine-zolazepam for remote chemical immobilisation. *Marine Mammal Science.*

Page, B., McKenzie, J., McIntosh, R., Baylis, A.M.M., Morrissey, A., Calvert, N., Haase, T., Berris, M., Dowie, D., Shaughnessy, P.D., and Goldsworthy, S.D. (2004) Entanglement of Australian sea lions and New Zealand fur seals in lost fishing gear and other marine debris before and after Government and industry attempts to reduce the problem. *Marine Pollution Bulletin,* 49, 33-42.

Page, B., McKenzie, J., and Goldsworthy, S.D. (2005) Dietary resource partitioning among sympatric New Zealand and Australian fur seals. *Marine Ecology Progress Series,* 293, 283-302.

Page, B., McKenzie, J., Hindell, M.A., and Goldsworthy, S.D. (2005) Drift dives by male New Zealand fur seals (*Arctocephalus forsteri*). *Canadian Journal of Zoology,* 83: 293-300.

Page, B., McKenzie, J., and Goldsworthy, S.D. (2005) Inter-sexual differences in New Zealand fur seal diving behaviour. *Marine Ecology Progress Series,* 304, 249-264.

Baylis, A.M.M., Page, B., Peters, K., McIntosh, R., McKenzie, J., and Goldsworthy, S.D. (2005) The ontogeny of dive behaviour in New Zealand fur seal pups (*Arctocephalus forsteri*). *Canadian Journal of Zoology* 83, 1149-1161.

Page, B., McKenzie, J., Sumner, M.D., Coyne, M., and Goldsworthy, S.D. (2006) Spatial separation of foraging habitats among New Zealand fur seals. *Marine Ecology Progress Series*, 323, 263-279.

"They say around here that once a year, on Midsummer Night's Eve, selkies who are seals the rest of the time come up out of the water and take the form of women. And if you find one of their discarded seal skins and take it home with you and hide it, then the selkie is bound to you until she finds her skin. And she may even love you a little, but she never stops looking for her skin. And she always finds it. It may take her a hundred years, but she finds it, and returns to the sea. Always."

Sea Change – Susan Stern.

ABSTRACT

Assessment of trophic interactions between increasing populations of New Zealand fur seals (*Arctocephalus forsteri*) and fisheries in southern Australia is limited due to a lack of species specific demographic data and an understanding of the factors influencing population growth. To establish species specific demographic parameters a cross-sectional sample of New Zealand fur seal females (330) and males (100) were caught and individually-marked on Kangaroo Island, South Australia between 2000 and 2003. The seals were aged through examination of a postcanine tooth, which was removed from each animal to investigate age-specific life-history parameters. Annual formation of cementum layers was confirmed and accuracy in age estimation was determined by examination of teeth removed from individuals of known-age. Indirect methods of assessing reproductive maturity based on mammary teat characteristics indicated that females first gave birth between 4-8 years of age, with an average age at reproductive maturity of 5 years. Among reproductively mature females, age-specific reproductive rates increased rapidly between 4-7 years of age, reaching maximum rates of 70-81% between 8-13 years, and gradually decreased in older females. No females older than 22 years were recorded to pup. Age of first territory tenure in males ranged from 8-10 years. The oldest female and male were 25 and 19 years old, respectively. Post-weaning growth in females was monophasic, characterised by high growth rates in length and mass during the juvenile growth stage, followed by a gradual decline in growth rates after reproductive maturity. In contrast, growth in males was biphasic and displayed a secondary growth spurt in both length and mass, which coincided with sexual and social maturation, followed by a rapid decline in growth rates. Age-specific survival rates were high (0.823-0.953) among prime-age females (8-13 yrs of age) and declined in older females. Relative change in annual pup production was strongly correlated with reproductive rates of prime-age females and adult female survival between breeding seasons.

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