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Life history studies of the southern elephant seal population at Marion Island

by

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Declaration:

I, …**Petrus Jacobus Nicholas de Bruyn**…… declare that the thesis/dissertation, which I hereby submit for the degree ……**PhD Zoology**…… at the University of Pretoria, is my own work and has not previously been submitted by me for a degree at this or any other tertiary institution.

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There is a pleasure in the pathless woods;

There is a rapture on the lonely shore;

There is society, where none intrudes,

By the deep sea, and music in its roar:

I love not man the less, but Nature more

George Gordon Noel Byron, Lord Byron. (1788–1824)

This work is dedicated to the wild inhabitants of that Jewel of the Southern Ocean, Marion Island, and to all the intruders who have expended much blood, sweat and tears in the glorious quest for knowledge.

Life history studies of the southern elephant seal population at Marion Island

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Degree: Doctor of Philosophy (Zoology/Mammalogy)

Holistic studies of mammalian life history factors and their consequences on population demography require an intensive, multifaceted field methodology and effort over long temporal scales. A 25-year longitudinal mark-recapture experiment on southern elephant seals, *Mirounga leonina*, at Subantarctic Marion Island provides such a foundation for demographic analyses and relevant methodology advancement. Two gaps in the methodology related to life history and population demographic research are, the absence of large samples of known mass individuals, and an inability to identify mother-pup relatedness. A novel three-dimensional photogrammetric technique is designed here that allows for mass estimation of large samples of southern elephant seals in the field. An effective temporary marking technique for unweaned pups is implemented that allows for identification of large samples of pups with known mothers prior to the maternal bond being severed at weaning. These known pups can then be marked with more robust tags and relatedness information is preserved long-term. Thus, mass estimates can now be applied as covariates in modelling analyses to address questions of, for example, maternal investment, kinship associated behaviour, and the consequences thereof on survival and reproductive parameters.

The state change in the Marion Island southern elephant seal population from decrease to stabilisation/increase is shown to have resulted from improved survivorship in both juvenile and adult female age classes. Male seals of all ages did not indicate improved survivorship following the period of decline. The inflexion in survivorship is identified as 1994, whence improved survivorship of juvenile seals preceded that of young adult females. This inflexion in survivorship is postulated to have resulted in a population trend inflexion around 1998.

Female southern elephant seals do not show evidence of actuarial senescence, but reproductive senescence is apparent after 12 years of age. A long-term reproductive cost (reduced breeding effort) is associated with early primiparity (age three) as compared with later primiparity (4- 5- or 6-year-old). The mean proportion of 3-year-old breeders has not increased after 1994 as has been hypothesized in previous studies. Contrary to previous assumptions, females do not as a rule breed every year. Annually interrupted breeding efforts are more common than consecutive breeding efforts. No difference in the proportions of interrupted *versus* uninterrupted breeding efforts was identified between periods of population decline and stabilisation/increase. Longevity as predicted by survival estimates exceeds the observed frequencies. This study provides unique longevity and fertility schedules for the species.

The improved survivorship, reproductive senescence and breeding schedules of female southern elephant seals in this population provide groundwork for re-evaluation of previous studies and their conclusions. The addition of relatedness and body condition information will allow for sophisticated multistate modelling of population demography in future studies. However, analytical procedures and techniques employed need to be meticulously designed and thoroughly thought through to avoid mis-interpretation of biological data.

In addition to a multistate single species analytical approach, the importance of an ecosystem approach to species population demographic studies is highlighted through the augmenting of data on relevant potential drivers of population change, such as killer whales, *Orcinus orca*.

Key words: *Mirounga leonina*, Southern Ocean, phocids, photogrammetry, mark-recapture, tagging, survivorship, senescence, longevity, population demography, methodology advancement, experimental design, ecosystem approach research

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Disclaimer

Each of the research chapters within this thesis was structured with scientific journal publication in mind. I apologise for some overlap and repetition in methods sections.