Chris Lalas 30 June 2008 comments on NIWA Client Report: WLG2008-35
'Pupping rate estimates for New Zealand sea lions' by D. J. Gilbert & B. L. Chilvers'

1. Introduction
At the 12 June 2008 CSP meeting I commented that the Gilbert & Chilvers Report did not address two implications of their results:

1. Effect on population growth rate.
2. Effect on the multiplier to estimate population size from pup counts.

I have co-authored two papers that have modelled the female population of NZ sea lions at Otago: Lalas & Bradshaw (2003) and Lalas et al. (2007).

2. My presentation at the 12 June 2008 CSL meeting
My comments and presentation were recorded at the end of the Minutes as:

> 'CL – presented some slides of his own modelling based on the Gales & Fletcher approach, using parameters from DG's report – population is not self sustaining, population size multipliers need to be higher, and fecundity would need to be doubled to allow for a sustaining population.
> DG – agrees the data gives higher population multipliers.'

(This is a realistic account of what I said; it would be more accurate if the start of the final phrase for CL began with 'e.g. fecundity' instead of 'and fecundity'.)

I presented two scenarios of female demography for a stable population of NZ sea lions, depicted here in Figure 1. I based these scenarios on data extracted from publications available in the public domain (i.e., not contracted reports). Results are presented as deterministic scenarios generated from a Leslie matrix model simulated on an Excel spreadsheet.

2.1 Simulation from Gales & Fletcher (1999) data: Figure 1
This simulation is relevant because it was used to derive a pup multiplier of 4.4 to estimate population size (excluding pups) from pup counts. (Note: a universal pup multiplier is valid only if population demography is stable.) Annual estimates for population size by the Department of Conservation are approximately 4.43 times the number of pups (Breen et al. 2003: p.531). Estimates for annual pup production are presented by Wilkinson et al. (2006: Appendix 1) for 1992/93-2003/04 and by Chilvers et al. (2007: Table 2) for 1994/95-2005/06. Estimates for population size in the New Zealand Sea Lion Species Management Plan: 2007-2017, Draft August 2007 (p. 6) indicate use of a pup multiplier of approximately 4.7. The scenario shown here in Figure 1 (left) produces a pup multiplier of 4.45.

Gales & Fletcher (1999) created stochasticity to estimate 95% confidence intervals in estimates for population size. This was done with a probability distribution generated from designated age-specific likely minima and maxima for survival and fecundity.

2.1 Simulation by Lalas: Figure 1
This simulation applies updates Gales & Fletcher (1999) with the application of real data presented in Breen & Kim (2006). The main difference is a later age of primiparity but the entered values for parameters still generate a stable population size. Both Dave Gilbert and Paul Breen pointed out at the 12 June meeting that my

values are too high (biased towards better than average females) but I am obliged to stay with published data.

The scenario shown here in Figure 1 (right) produces a pup multiplier of 5.32, 20% greater than 4.45, where (5.32-4.45)/4.45 = 0.20. This indicates that the Gales & Fletcher (1999) pup multiplier underestimates population size by approximately 20%.

3. Two implications if the Gilbert & Chilvers values for parameters are correct

3.1 The sea lion population size is collapsing: Figure 2

This scenario indicates that the sea lion population size is decreasing by 7.5% annually, equivalent to an 88% reduction in three generations.

Values for parameters were deduced from data collection starting in 1987. Therefore the scenario created should not only predict future trends in population size but also represent trends through the last 20 years. The scenario does not do this, clearly shown by the fact that there has not been a 75% reduction in population size. Hence this scenario cannot be regarded as a realistic predictor for future trends.

3.2 The estimate for population size from pup counts is incredibly high

The scenario shown here in Figure 2 produces a pup multiplier of 8.37, 88% greater than the 4.45 from the simulation of Gales & Fletcher (1999) in Figure 1 , where (8.37-4.45)/4.45 = 0.88. If taken as correct, this indicates that the Gales & Fletcher (1999) pup multiplier underestimates population size by approximately 90%.

3. Possible errors in Gilbert & Chilvers values for parameters

At the 12 June meeting Paul Breen, Ed Abraham and Patrick Cordue suggested that accounting for tag loss could be the source of error.
On page 10 of the report tag loss is defined as the loss of the tag from single-tagged animals, the loss of both tags from double-tagged animals and the loss of readability of tags. Tag loss was designated as an age-independent 4% annually.

My comment:
Loss of tags and loss of readability of tags are unrelated and age dependent.

In my opinion the annual rate of loss of tags by females is likely to be distinctly greater in the first year after tagging and then age independent in older animals.

From my monitoring at Otago I am more definitive about age dependence for loss of readability of tags. All tags are readable for sea lions up to 3-years old. The black of the numerals on tags starts to disappear at 4 years on the 1990s tags and at 3 years on more recent tags. Numerals are embossed and so can be read for a few years after the loss of black highlighting. The Report does not define ‘loss of readability’ – does this refer to the loss of black highlighting or to the loss of embossing?

References

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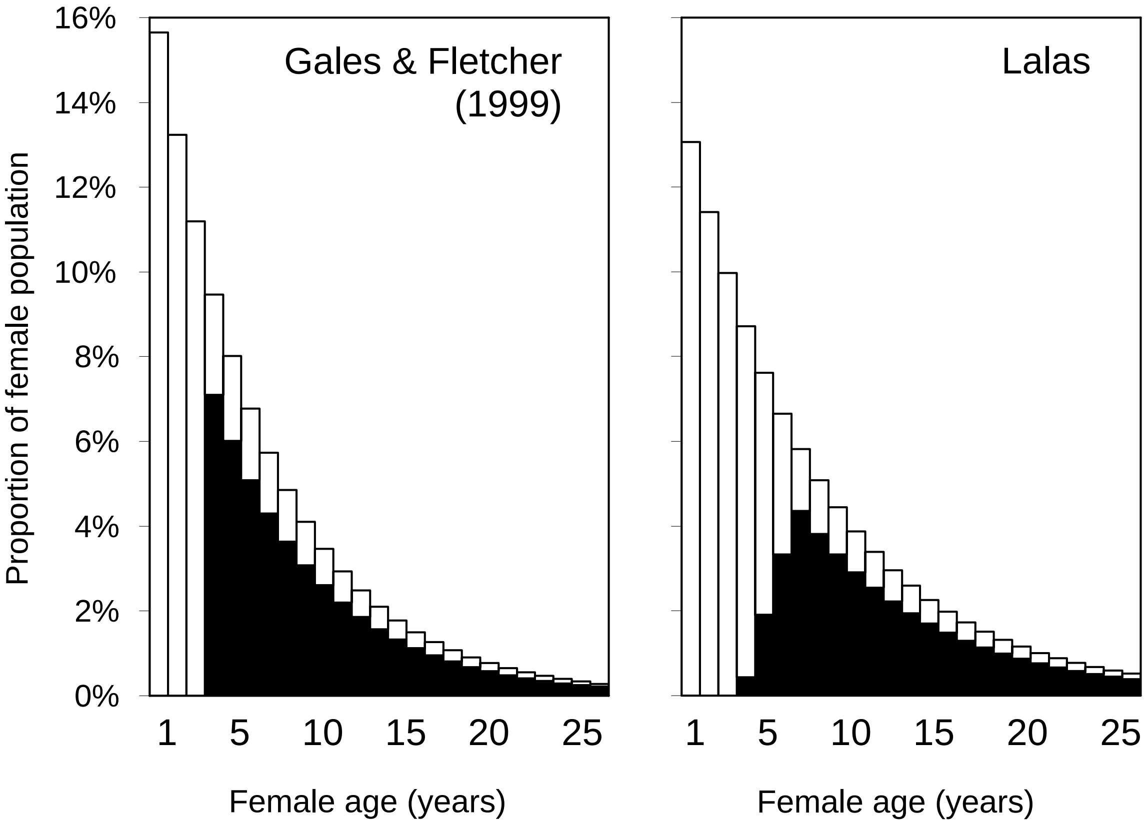

Figure 1: Female demography for a stable population size of NZ sea lions: comparison between two scenarios. Black = with pups; White = without pups.

Values for parameters

	Annual survival		Annual fecundity	
Age (years)	G&F	Lalas	G&F	Lalas
0 (i.e. pups)	0.70	0.70	0.00	0.00
1 - 3	0.85	0.88	0.00	0.00
4	0.85	0.88	0.75	0.05
5	0.85	0.88	0.75	0.25
6	0.85	0.88	0.75	0.50
≥7	0.85	0.88	0.75	0.75

Origin of values for parameters in Gales & Fletcher (1999) = G&F
Demography was derived from designated age-specific ‘most-likely’ values for survival and fecundity.

Origin of values for parameters in Lalas simulation
For first year (pup) survival I retained the G&F 0.70 because this appears realistic (it matches the minimum likely value at Otago). Annual survival for older females was taken as the average through 4 years by 135 breeding females branded in 2000 at Sandy Bay; data from Breen & Kim (2006: text p. 474).
Age-specific fecundity was derived from the demography of 822 females from 3 years 1999-2001; data from Breen & Kim (2006: Table 3).

Neither simulation accounts for the possible effects of senescence.

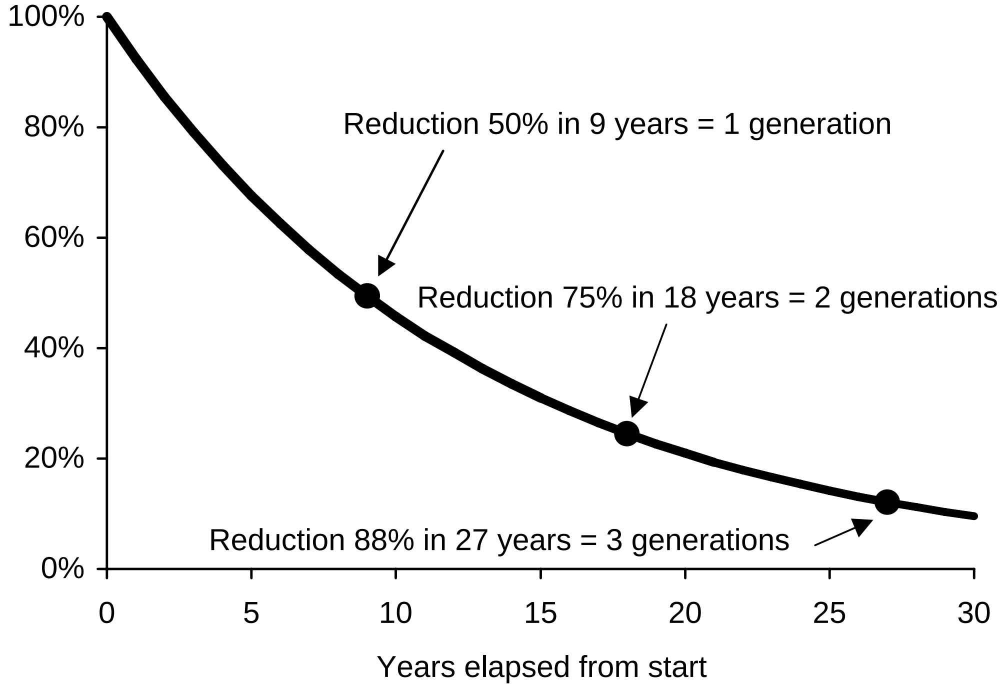

Figure 2: Possible effect of the Gilbert & Chilvers Report parameters on NZ sea lion population size

Origin of values for parameters from Gilbert & Chilvers Report:

First year (pup) survival = 0.50
Calculated from Table 2 'First year mortality' as the average for 10 cohorts 1990-2003. (Excludes 1987 cohort: at the 12 June meeting Dave Gilbert said that this was a realistic thing to do).

Age-specific annual survival for older females was measured off the survival curve in Figure 8.

Age-specific fecundity was measured off the solid line curve in Figures 6 & 7.

Generation time:
Here calculated as median age of females that give birth in one year: 9 years (8.9). (Note that the concomitant average age is greater than median age = 10.7 years.)