Estimation of sea lion demographic parameters - methodological update (POP2007/01 Obj 3)

Darryl MacKenzie

Proteus
wildlife research consultants

Overview

- Demographic parameters to be estimated
  - Pup production.
  - Total population size.
  - Survival.
  - Reproduction.
  - Recruitment to breeding population.

Pup Production

- Currently a mix of mark-recapture and direct counts.
- These require some assumptions that may potentially introduce some bias if violated, however level of effort would suggest any bias is likely negligible.
- Recommend current methods are continued.

Pup Production

- Alternatively, given an estimation of the adult female breeding population (*N*) and there pupping rate (*p*), and estimate of the number of pups produced would be:

$$P = N \times p$$

- May be a useful double-check, although estimating population size may be problematic.

Total Population Size

- Currently done using an approach developed by Gales and Fletcher (1999).
- Based on
  - Pup production estimates
  - Assumed population structure
  - Stable age distribution
  - Estimates of demographic parameters not specific to NZ sea lions

Total Population Size

- Proposed to assess robustness of population size estimates to:
  - Assumed population structure
  - Estimates of demographic parameters not specific to NZ sea lions

Total Population Size

- Because of stable age distribution assumption, population size estimates are effectively rescaled pup production estimates.
  - i.e., the reported mean population size estimates for each year from Chilvers (2007) is approximately 4.75 x number of pups.

Total Population Size

- General approach is not likely to be useful for tracking trajectory of total population size.
- Changes in pup numbers may not reflect a change in adult breeding population size.

Total Population Size

- There is some information in the daily resight records that could be used to estimate population size.
- Likely only feasible for specific tagging cohorts and beaches.
  - May be difficult to obtain a total population size (to be assessed once data analysis begins).

Pollock's Robust Design

- Exploits the additional information that is contained within the daily resights, rather than pooling to seen/not seen each year.

	1	2	3
Daily	011011100	000000000	100100001
Pooled	1	0	1

Pollock's Robust Design

- Allows estimation of additional parameters.
  - Relax assumptions required when using only the pooled data.
  - Account for the within season biology and sampling processes more closely.
- Can be extended to multiple-states
  - e.g., reproductive status or number of tags.

Survival, Reproduction and Recruitment

- PRD extended to multiple states offers the ability to estimate all 3 demographic parameters while allowing for issues such as tag loss, and misidentification of breeders.

Survival, Reproduction and Recruitment

- For example:

State	Description
1	Breeder, ≥1 tag
2	Breeder, 0 tags
3	Non-breeder, ≥1 tag
4	Non-breeder, 0 tags
5	Dead

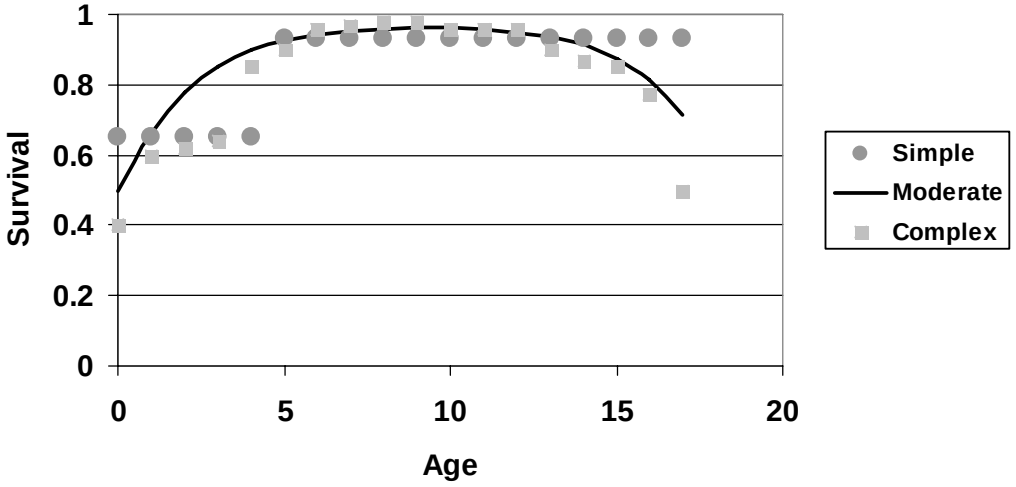
- Transitions from states 1,3→2,4 tell us about tag loss.
- Transitions from states 1,2→3,4 tell us about reproduction.
- Transitions from states 1,2,3,4→5 tell us about mortality.

Survival, Reproduction and Recruitment

- Within season, daily surveys could provide information about breeder misclassification.
  - Need to assume misclassification is only in one direction.
- Can allow resight probabilities to vary by state.
- Data collected under PRD also allows further relaxing of assumptions.
  - e.g., animals that arrive late/leave early

Survival, Reproduction and Recruitment

- Can build in functional relationships between demographic parameters and age (for known age animals).



Survival, Reproduction and Recruitment

- Similarly, will consider models where reproduction is a function of age.
- Define recruitment as the first successful breeding attempt.
- Different functions for first reproduction (recruitment) and subsequent reproduction.

Survival, Reproduction and Recruitment

- General methods proposed here are well established within the mark-recapture community.
- I don't expect annual estimates of all parameters to be estimable, but will start with a general model then simplify, searching for a parsimonious model based upon Akaike's Information Criterion.

Summary

- Pup production – continue current methods and investigate feasibility of a second measure.
- Total population size – concerns about reliability of current method. Data may not exist to obtain a total population size estimate using other methods.

Summary

- Survival, reproduction and recruitment – tag-resight data *appears* to be a rich source of information that has not been fully utilised. Multi-state mark-recapture methods provide a well established statistical framework for analysing this data.