

WILD 502
 Lab 8 - Jolly-Seber Modeling

Today, you'll learn how to implement Schwarz and Arnason's formulation of the Jolly-Seber model, which is often referred to as a POPAN model. The lab focuses on what types of parameters are estimated and how they might be used. The exercise leans heavily on Chapter 12 of *CW* (written by Carl Schwarz and Neil Arnason), so it'll be helpful to follow along with the appropriate sections of that chapter.

1. Open MARK and choose 'File', 'New', 'POPAN', and use '*chaseAd.inp*' as your input file. Provide the input data summary for this dataset, which is available from MARK via the Output menu.
2. Examine the input file; determine the number of occasions, groups, and individual covariates that are in the file (see pg. 12-15 of *CW*); and report those values. Set up the MARK analysis accordingly.
3. Take special notice of the comments at the top of the input file regarding the interval lengths between occasions, set the intervals in MARK accordingly, and report the interval lengths.
4. Run the full time-varying model $\{\phi_t, p_t, pent_t\}$ while following page 12-17 of *CW* regarding use of the multinomial logit link for the *pent* parameters (these are referred to as β in *WNC* on page 509, as *b* parameters in Ch. 12 of *CW*, and as *pent* in MARK, but they all mean the same thing). Provide a table with estimates for those parameters that can be estimated – label the estimates so that it's obvious which estimates go with which occasions or intervals (Consult Table 12.2 for help with identifying which parameters cannot be estimated).
5. How many capture probabilities (the p_t) are there in the POPAN model, and how does this number compare with the number of p_t that would be considered in a CJS analysis of these same data?
6. On page 510 of *WNC*, they state that you estimate 3K-3 parameters with this model. What is 3K-3 for this study and does the number of estimable parameters you identified in the previous question match that number?
7. How many parameters does MARK report as having estimated? Adjust the number if necessary.
8. What is the definition of $pent_2$ and your estimate of it for the time-varying model?
9. Run the model $\{\phi_t, p_t, pent_t\}$. Now how many parameters are identifiable and what are your estimates of them (again, provide a table that makes it obvious which estimates go with which occasions or intervals)? (Think about why holding p constant allows you to have identifiable estimates of each parameter; it may be helpful to look at Table 12.2 again.)
10. How many parameters does MARK report as having estimated? Adjust the number if necessary.
11. Which of the 2 models run so far is better supported by the data?
12. Use the estimates to calculate the probability that an animal in the superpopulation was present when sampling began, i.e., calculate \hat{b}_0 . Show your calculations and your estimate.
13. Use \hat{N} & \hat{b}_i to obtain \hat{B}_i , where $\hat{B}_i = \hat{N} \cdot \hat{b}_i$, and to obtain $\sum_{i=0}^7 \hat{B}_i$. Report your estimates. Note: you could also obtain \hat{B}_i using $\hat{B}_i = \hat{N}_{i+1} - \hat{\phi}(\hat{N}_i - n_i + R_i)$ if you counted how many deaths on capture there were in the dataset for each occasion.

14. Look at MARK's estimates of derived parameters (\hat{B}_i^* , \hat{B}_i , \hat{N}_i , \hat{N}^*). Note: \hat{B}_i^* represents gross

births between i and $i+1$. These are calculated as $\hat{B}_i^* = \hat{B}_i \frac{\log(\hat{\phi}_i)}{(\hat{\phi}_i - 1)}$, e.g.,

$$\hat{B}_1^* = 14.927 \cdot \frac{\ln(0.584^{1.5})}{(0.584^{1.5} - 1)} = 14.927 \cdot \frac{-0.807}{-0.554} = 21.749 \text{ and for the second occasion}$$

$$\hat{B}_1^* = 110.39 \cdot \frac{\ln(0.926)}{(0.926 - 1)} = 110.39 \cdot \frac{-0.077}{-0.074} = 114.69 . \text{ The equation assumes a uniform entry of}$$

new animals during the sampling interval and a uniform mortality of those individuals during the interval as well. The quantity can sometimes be of interest as discussed by Schwarz and Arnason (1996) for spawning salmon. Can you think of a situation where these would be interest in ecological sampling?

15. Show calculations and estimates for each time-specific population size using equations shown on page 12-20 of *CW*.

16. Now that you've seen the POPAN model in use and worked through this example, describe an example for which this type of modeling would be useful in species of interest to you where the occasions are each 1 year apart and the work is done across a number of years.

17. Next, describe an example for which this type of modeling would be useful in species of interest to you where the occasions are each close in time (days to weeks) and the work is done within 1 season.

Finally, use Google Scholar (<http://scholar.google.com/>) and search on "Schwarz Arnason 1996 Biometrics", which will give you a screen something like the one below. Click on the "Cited by ..." link for the article and take a look at some of the articles that have cited the article in the past few years. Does it seem to you that this method is being used for real animals and problems of interest? Provide a few sentences of evidence to back up your answer.

Google Scholar

Schwarz and Arnason 1996 Biometrics

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[PDF] A general methodology for the analysis of capture-recapture experiments in open populations

C.J. Schwarz, A.N. Arnason - *Biometrics*, 1996 - JSTOR

We trace the development of a likelihood function representation for the open-population capture-recapture (Jolly-Seber) experiment. We find that the modeling of the birth process in the general model is not consistent with the reduced death-only model and that all formulations to date lead to difficulties in imposing constraints upon the parameters of the birth process. We propose a generalization to the usual Jolly-Seber representation that ...

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