WILD 502
Lab 9 – The Robust Design

Supporting material: Ch 19 of *WNC*; Ch 15 of *CW*

Today's lab is intended to introduce you to some of the core concepts of modeling with the robust design. We will use data from 5 primary occasions each of which has 3 secondary occasions. To help you see the connections between estimation based on the data from closed sessions and from open sessions, we will start with the *ad hoc approach*. To do that we will (1) model the data from each of the closed sessions, (2) model the data from the primary sessions with CJS models, (3) examine the estimates of N_i, p_{ij}, p_i* (from closed modeling), φ_i, and p_i^0 (from CJS modeling), where *i* represents the primary occasion and *j* represents the secondary occasion within primary occasion *i*, (4) calculate temporary emigration rates from the estimates of p_i* and p_i^0. After doing that, we'll model the same data using the robust design model to see how the estimates to compare with those obtained from the *ad hoc* approach and to see the benefits of using the likelihood approach.

To do all that, we will need 7 input files: 5 files for the closed sessions, 1 for the CJS model, and 1 for the robust design analysis. The files are labeled: (1-5): rd_simple_pocc1.inp, …, rd_simple_pocc5.inp; (6) rd_simple1_cjs.inp; and (7) rd_simple1.inp. These are simulated data and the underlying process is described in chapter 15 of *CW*. All data are for 1 group without age structure or covariates.

1. Analyze the data from each of the primary occasions using closed-captures models with models M(0), M(t), M(b). Record which model is best for each data set, and record the estimates of p_{ij} and N_i for <u>*model M(0)*</u> . Calculate p_i*, where $p_i^* = 1 - \prod_{j=1}^{l_i}(1 - p_{ij})$. Fill in the table below.

Primary occasion	$\hat{N}_i \;\; se(\hat{N}_i)$	$\hat{p}_{ij}$ se($\hat{p}_{ij}$)	$\hat{p}_i^*$	Best closed model structure
1				
2				
3				
4				
5				

2. Next, analyze the data in rd_simple1_cjs.inp with models that evaluate the presence of time variation in *phi, p,* or both. Report which model is best supported and provide the estimates from the top model (we'll ignore model-selection uncertainty for now).

Parameter	Estimate	Standard Error	Lcl 95% CI	Ucl 95% CI
φ_1				
φ_2				
φ_3				
φ_4				
p_2				
p_3				
p_4				
p_5				

3. Use the estimates above to fill in the following table for those occasions for which both $\hat{p}_i^*$ from closed models and $\hat{p}_i^{CJS}$ from CJS modeling are available.

Primary occasion	$\hat{p}_{ij}$	$\hat{p}_i^*$	$\hat{p}_i^{CJS}$	$\hat{\gamma}_i'' = 1 - \frac{\hat{p}_i^{CJS}}{\hat{p}_i^*}$

4. Provide a brief explanation of why a comparison of $\hat{p}_i^*$ from closed models and $\hat{p}_i^{CJS}$ from CJS modeling is informative about temporary emigration.

5. Use the robust design model with the 'closed-captures' option in MARK to analyze the data in rd_simple1.inp for the 3 models described in section 15.6.1 (page 15-14, 3rd paragraph) of *CW*: (*i*) no movement, (*ii*) random temporary emigration, and (*iii*) Markovian temporary emigration. Provide a model-selection table and describe the key inferences that can be made from the analysis.

6. Provide a table of parameter estimates obtained from the best robust design model.

7. How closely did your estimates from the *ad hoc* and likelihood approaches match?

8. What aspects of the biology were you unable to detect with the *ad hoc* approach used here?

9. If you ignored temporary emigration, what, if any, biases were present in estimates of *S, p,* and *N* from (a) the *ad hoc* approach or (b) the 'no movement' model from the likelihood approach?

10. Based on your best robust design model, did the probability of an animal being off the sampled area on occasion 3 and 4 depend on whether or not it was present or absent on the previous occasion? What is the evidence for this in the estimates? Can you think of a biological situation where this might occur? If so, please describe it briefly.