Inferences About Variation in Parameters Over Time

Population Modeling
University of Florida
Gainesville, FL
February-March 2016

USGS
science for a changing world

Estimation of Temporal Variance in Survival: A Proposal

$$S^2 = \frac{1}{n-1}\sum_{i=1}^{n}(\hat{\phi}_i - \bar{\hat{\phi}})^2; \quad \bar{\hat{\phi}} = \frac{\sum_{i=1}^{n}\hat{\phi}_i}{n}$$

where,
S^2 is the estimated variance of point estimates;
n is the number of survival estimates

Estimation of Temporal Variance in Survival: A Proposal

- Problem: this estimated variance has 2 components
  - True temporal variance of underlying survival parameters
  - Sampling variance and covariance associated with
    - capture probability <1 and
    - binomial variation in numbers of marked animals that survive and are caught

Estimation of Temporal Variance in Survival: Some Notation

- F denotes all of the information in nature's realization of the true survival rates (including true variation and covariation of the underlying survival parameters)
- $\hat{\tau}^2 =$ the estimated true temporal variance of survival probability (accounting for true variances and covariances)

Estimation of Temporal Variance in Survival

$$\hat{\tau}^2 = S^2 - \frac{1}{n}\sum_{i=1}^{n}\hat{E}[\mathrm{var}(\hat{\phi}_i \mid F)]$$

$$+ \frac{2}{n(n-1)}\sum_{i<j}\hat{E}[\mathrm{cov}(\hat{\phi}_i, \hat{\phi}_j) \mid F]$$

Estimation of Temporal Variance in Survival: Implementation

- Program MARK provides a variance components algorithm to compute;
  - Estimate of temporal variance
  - Shrinkage estimates of annual survival based on a random effects approximation

Variance Components and PVAs: How to Proceed?

- We can decompose S^2 into 2 components:
  - True temporal variance of survival
  - Average sampling variance (including covariance effects)
- How would we include these components in a set of simulations (e.g., 1000 simulations of 100 years each) designed to compute number of extinctions, say?

Variance Components and PVAs: How to Proceed?

- Step 1: random draw of mean survival from estimated sampling distribution
- Step 2: use estimated temporal variance to produce variation around the mean selected in step 1 for all years of this iteration
- Step 3: repeat steps 1 and 2

(e.g., McGowan et al. 2011)

Temporal Variances: Bottom Line

- Knowledge of variance components is important for:
  - Inference/estimation
  - Modeling and prediction