# Capture-recapture Models for Open Populations: Multiple Ages

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## Multiple-Age Models

- Pollock (1981) developed CJS-type model for multiple age case
- Permits different age classes to have different survival and capture probabilities
- Developed for situation where animal can be aged on capture
- Other models deal with situation where animals cannot be aged on capture but age is known only for animals marked as young (Buckland 1980, 1982, Loery et al. 1987)

## 2-Age Model of Pollock (1981): Sampling Design

- Open-population capture-recapture study
- Animal identified as young or adult at capture, marked and released
- Time interval required to make transition from young to adult equals the interval between sample periods (e.g., annual samples for birds)

## Multiple-Age Model of Pollock (1981): Notation for 2 Ages

- $\phi_i^{(0)}$ = probability that young animal survives from sample period $i$ to period $i$+1 (transition between young and adult occurs during this period)
- $\phi_i^{(1)}$ =survival probability for adults, $i$ to $i$+1
- $p_i^{(1)}$ = capture probability for adults in $i$

## 2-Age Model of Pollock (1981): Capture History Expectations

- P(01101 | released as adult in 2) =

$$\phi_2^{(1)} p_3^{(1)} \phi_3^{(1)} (1 - p_4^{(1)}) \phi_4^{(1)} p_5^{(1)}$$

- P(01101 | released as young in 2) =

$$\phi_2^{(0)} p_3^{(1)} \phi_3^{(1)} (1 - p_4^{(1)}) \phi_4^{(1)} p_5^{(1)}$$

## 2-Age Model of Pollock (1981): Inference

- Model provides a probability structure for each possible capture history
- The likelihood is proportional to the product of these probabilities for all of the observed capture histories

## Multiple-Age Model of Pollock (1981): Additional Modeling

- Additional modeling abilities with multiple-age models are the same as those for single age models
  - Multiple groups
  - Capture-history dependence
  - Time-specific and group-specific covariates
  - Individual covariates

## Multiple Age Models: Assumptions

- Similar to those of single-age models
- Homogeneity of rate parameters now applies within age classes
- Time interval between sample periods corresponds to time needed to make age class transition