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Group	# Released in year 1	# Recaptured in year 2
High flow	50	30
Average flow	50	30
Low flow	50	30

Conclusions?

What are the Rates?

- Return rates
    - *S x p = 30/50 = 0.6*
- How many combinations of *S & p* can result in observed data?
    - Infinite # of combinations!
    - Combinations might differ by group

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Group	Survival Rate	Capture probability	R(i) X S(i) x p(i)
High flow	.90 (45/50)	.667 (30/45)	50 x .9 x .667 = 30
Average flow	.80 (40/50)	.750 (30/40)	50 x .8 x .750 = 30
Low flow	.70(35/50)	.857 (30/35)	50 x .7 x .857 = 30

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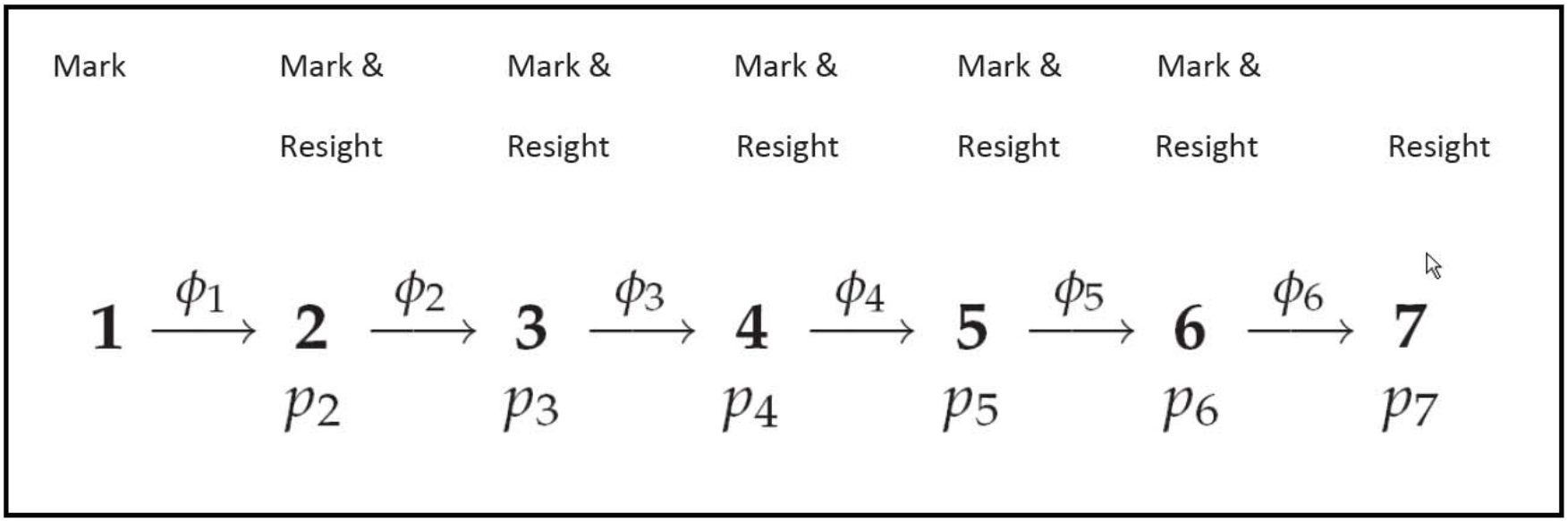
Cormack-Jolly-Seber Models



φ - apparent survival rate

- φ_i = probability that a marked animal in the study population at sampling period *i* survives until period *i*+1 and remains in the population

- 1– φ represents both animals that died and animals that left the population (emigration)

- In general, $\varphi < S$, where S = true survival rate

- p_i is the probability that a marked animal in the study population at sampling period *i* is captured or observed during period *i*

Assumptions

1. Every marked animal present in the population at sampling period *i* has the same probability p_i of being captured or resighted

   – Use covariates such as age, season, etc. to handle possible heterogeneity

   – Heterogeneity typically produces small bias in $\hat{\phi}_i$

   – Bias is typically negative

Assumptions

2. Every marked animal present in the population at sampling period *i* has the same probability φ_i of survival until sampling period *i+1*
   - Use covariates such as age, season, etc. to handle possible heterogeneity
   - Bias tends to be positive but … transient behavior tends to cause negative bias
     - Transients = animals that are released and then move to locations that are never subject to trapping
     - Transients effectively permanently emigrate: φ=0

Assumptions

3. Marks are neither lost nor overlooked and are recorded correctly

Assumptions

4. Sampling periods are instantaneous (in reality they are very short periods) and recaptured animals are released immediately

- If not true, then induce heterogeneity in φ
- Animals caught early in a long period of trapping (e.g., 2 months) may have lower φ than do animals caught at the end
- Consider how much mortality occurs during period of recapture

Assumptions

5. All emigration from the sampled area is permanent
   - Produces extreme heterogeneity in p
     - $p=0$ for temporary emigrants
   - If emigration is temporary and random,
     - Estimates of φ = unbiased
     - Estimates of p = prob(stay in study area) * prob(capture if in study area)
   - If emigration is temporary and not random, can get negative bias in φ

Assumptions

6. The fate of each animal with respect to capture and survival probability is independent of the fate of any other animal

   – If not true, don't have as much data as you think you do
     - Pick models that are overly complex
     - Overly confident in estimates (CI's too narrow)