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(3) Capture-mark-recapture
- Covered in the previous lecture

Pros

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Cons

- Batteries don't last as long as bands
- When fate is unknown, analysis can be hard
- Transmitters may influence vital rates and behavior

Design

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- x of the n animals survive
- The estimate of survival over the time interval is:

$$\hat{S} = \frac{x}{n}$$

Assumptions

(1) Fates are independent
(2) Fates are known
(3) All individuals are exposed to mortality during the same time interval

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Censoring occurs when the time of mortality is not directly observed

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  - Battery failure
  - Emigration

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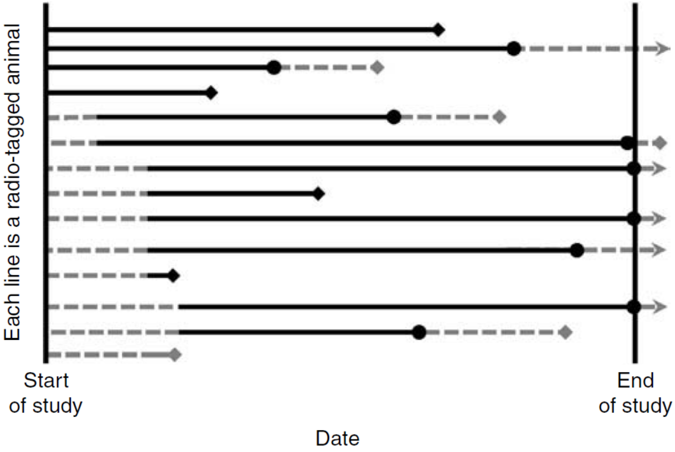
If censoring occurs, the Kaplan-Meier estimator is more appropriate than the binomial model.

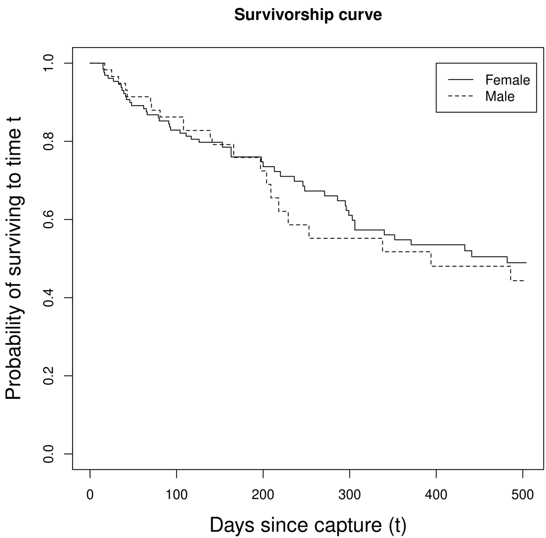
Censoring



Diamonds indicate mortality. Circles indicate censoring.
Black lines show the observation period.

$$\hat{S}_t = \prod_{j:t_i \leq t} \left(\frac{r_j - d_j}{r_j} \right)$$

S_t – probability of surviving to time t
r_j – number of individuals “at risk” prior to time t
d_j – number of mortalities prior to time t



https://youtu.be/Mgp46izlfeo

Critical Assumption:
Censoring must be independent of survival

- It's fine if transmitters fail randomly
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Censoring must be independent of survival

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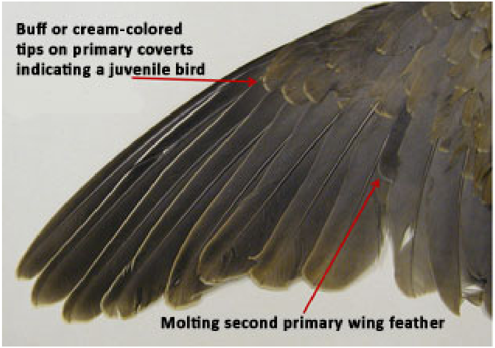
Consequence of violating this assumption:
If an animal dies, but you mistakenly right censor it because you think its battery died, survival will be over-estimated.

Standard practice

- We have a pile of wings that can be aged
- We assume the age ratios tell us something about survival



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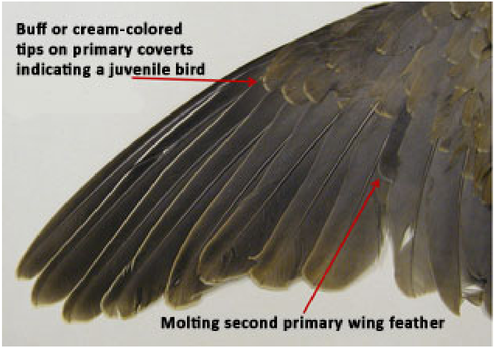

There are many problems with this

Suppose a cohort of individuals is monitored over time, so that we can obtain information about survival.

$$n_{i+1,t+1} = n_{i,t} S_{i,t}$$

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All is well. This is a valid approach based on the binomial model.

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... is not the same as data from "standing age distribution"

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Standing age distribution data can't be used to estimate survival, unless...

- Population is at the stable age distribution
- $\lambda = 1$

Pitfall II

Population reconstruction refers to the calculation of the abundance and age distribution of a cohort at some initial time, usually based on "ages at death".

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Shouldn't use this type of "reconstruction data" as real data in a subsequent analysis.

Pitfall III

The age data are biased

- Age data not representative of actual age distribution
- Hunting, trapping, and capture-recapture methods do not evenly sample the population

Avoiding the pitfalls

When estimating survival, it is always good to...

- Collect more than 1 year of data
- Follow multiple cohorts of individuals over long periods of time
- Estimate survival using telemetry or mark-recapture methods