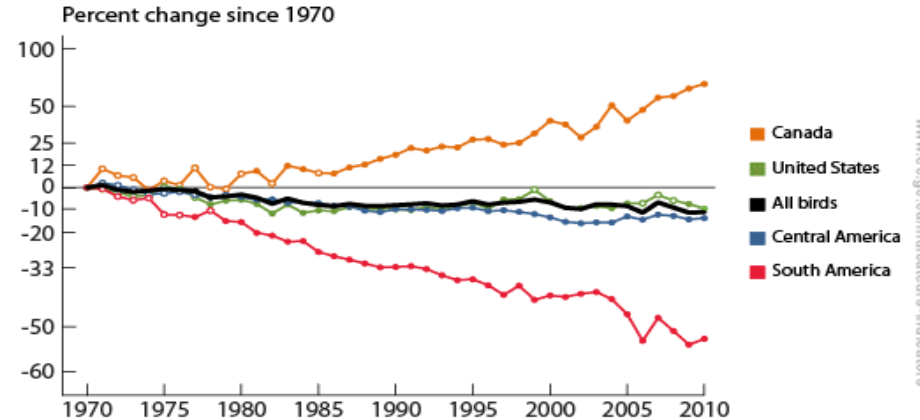


Analysis of demographic data

SSA 200

Estimating population vital rates

- Can use counts to model change in population size and the effect of covariates
- Intrinsic population characteristics govern population dynamics
- Stressors and threats often act directly on these rates
- This can help guide conservation actions to where it will be the most helpful and examine effects of potential management actions



Change in population size
 λ

$$= \text{births} + \text{immigration} - \text{deaths} - \text{emigration}$$

Fecundity/Recruitment

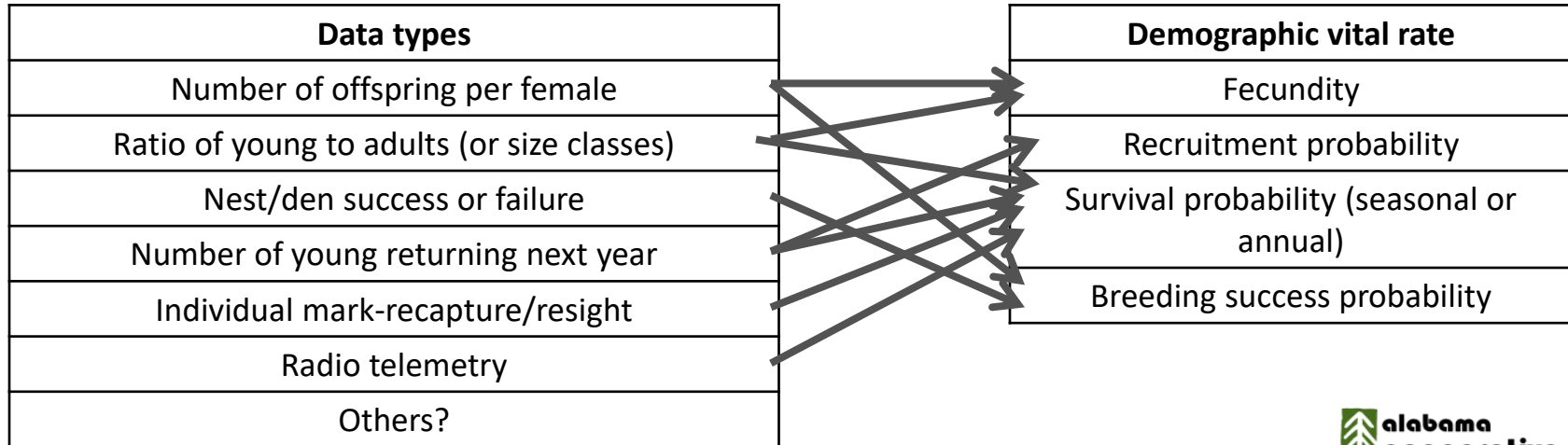
- Nest/den monitoring
- Reproductive success/failure
- Number of offspring produced
- Age ratios

Apparent survival

- Individual capture-mark-recapture
- Radio telemetry

Demographic data types

- Many different types, depends on ecology/life history of species of interest
 - Number of broods/litters per season
 - Breeding site fidelity
 - Etc.



Estimating fecundity

- From a population growth perspective, recruitment into breeding population is more important than fecundity
 - A product of many events: reproductive success, juvenile survival, site fidelity/dispersal
- Often easier to collect data on breeding success than recruitment
- Can estimate from individual-level data (nest/den success) or population-level data (ratio of young to adults)

GLMs to estimate fecundity

- Include ecological covariates to determine important drivers of breeding success
- Type of GLM depends on response variable
 - Number of offspring per female →
 - Successful breeding (yes/no) →

Estimating survival/mortality

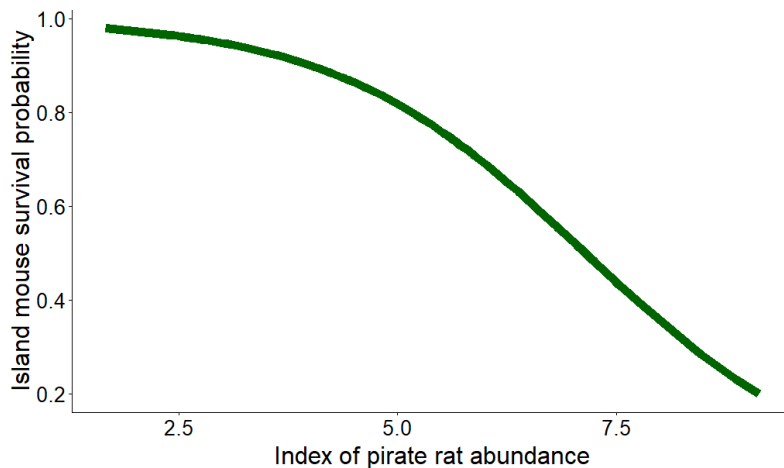
- Radio telemetry → known fate models
 - Assume perfect detection of individuals
- Individual capture-mark-recapture → Cormack-Jolly-Seber (CJS) models
 - Data can come from a variety of sampling methods
 - Physical recapture (trapping array)
 - Photographic re-encounter (camera traps)
 - Re-sightings (field-readable tags, individually-identifiable marks)
 - Noninvasive genetic sampling (hair snares, scat collection)
 - Assume **imperfect detection** of individuals

Linking survival probability to covariates

- **Logistic regression** is at the heart of survival estimation

$$\text{logit}(S) = \beta_0 + \beta_1 * \text{Pirate rat abundance}$$

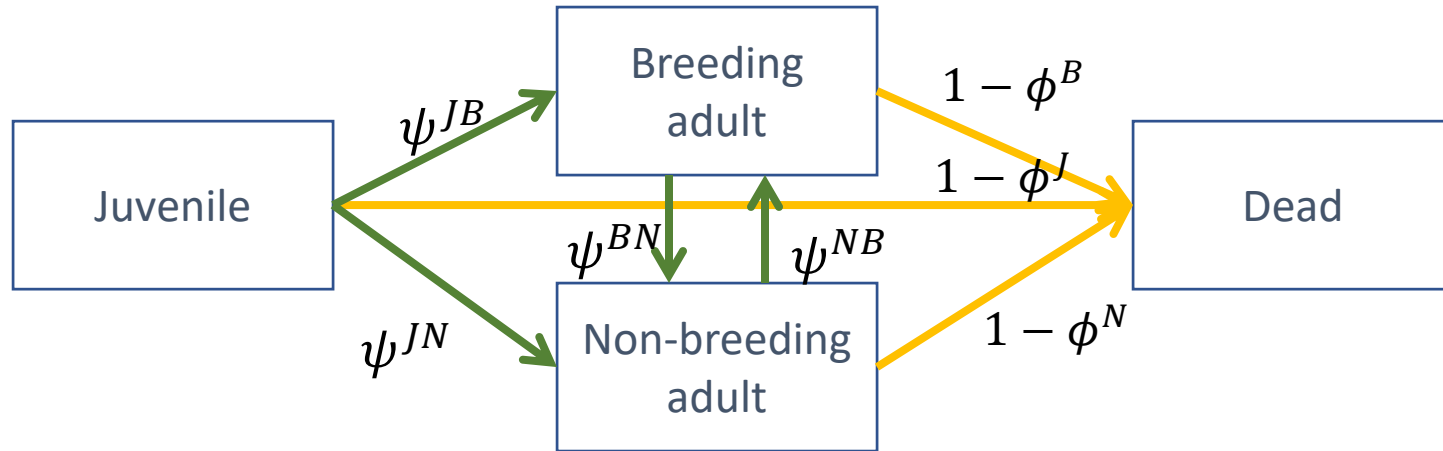
- If $\beta_1 > 0$, then pirate rate abundance has a **positive** effect on survival
- If $\beta_1 < 0$, then pirate rate abundance has a **negative** effect on survival



Multistate models

- Used to estimate transition probabilities among different physical sites or biological states
- Look similar to matrix models, but individuals can move back and forth between states
 - Breeder/non-breeder status
 - Disease status
 - Movement among study areas
- Very flexible and applicable to a range of situations

Example – breeding/non-breeding status



	J	B	N	D
J	0	$\phi^J \psi^{JB}$	$\phi^J \psi^{JN}$	$1 - \phi^J$
B	0	$\phi^B (1 - \psi^{BN})$	$\phi^B \psi^{BN}$	$1 - \phi^B$
N	0	$\phi^N \psi^{NB}$	$\phi^N (1 - \psi^{NB})$	$1 - \phi^N$
D	0	0	0	1

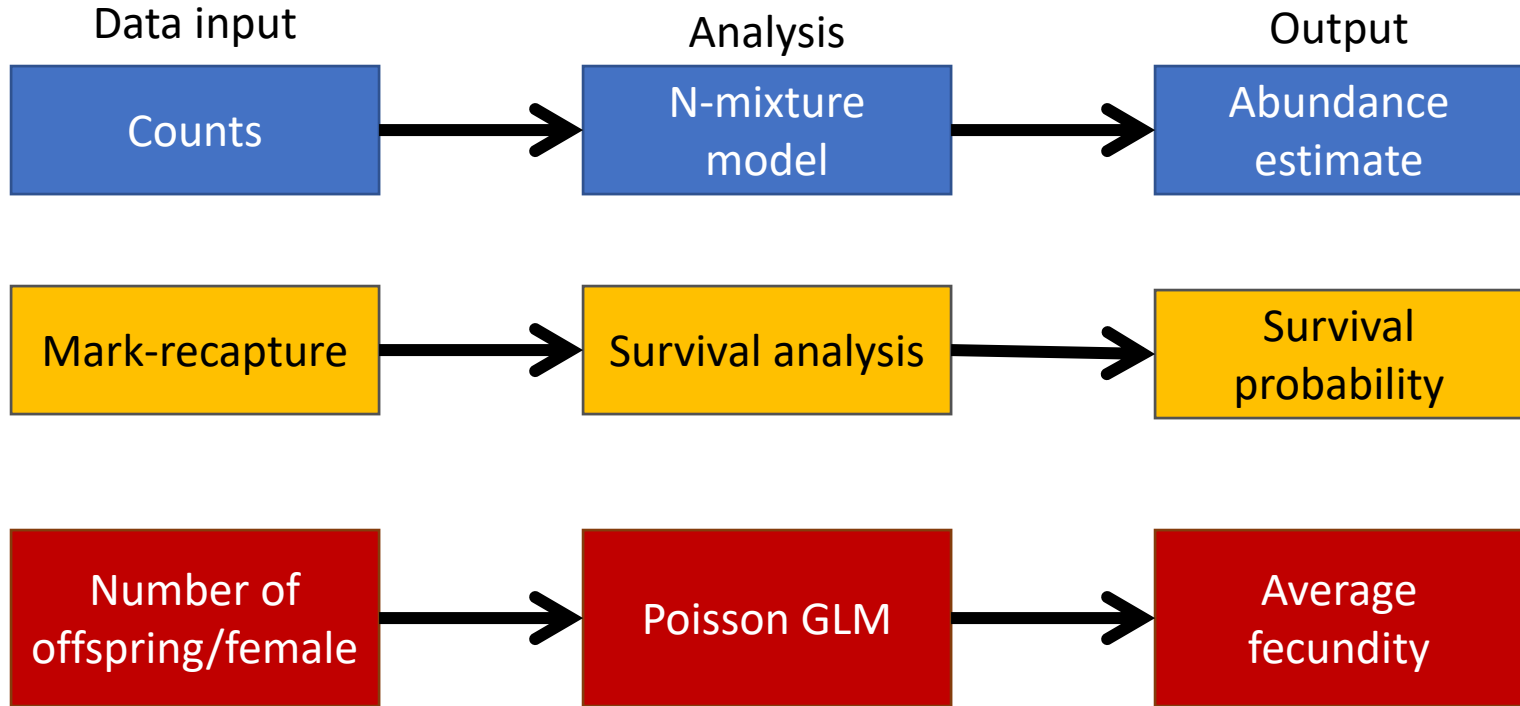
Extensions of multistate models

- Range of applications, not just individual mark-recapture data
- Used in both estimation and projection
- Migratory connectivity
 - probability of moving among multiple breeding and wintering sites
- Multistate occupancy analysis
 - change in occupancy state of sites (e.g. many, few, or none detected, detected with and without breeding activity, etc.)
- Ecological succession
 - change in dominant land cover type over time

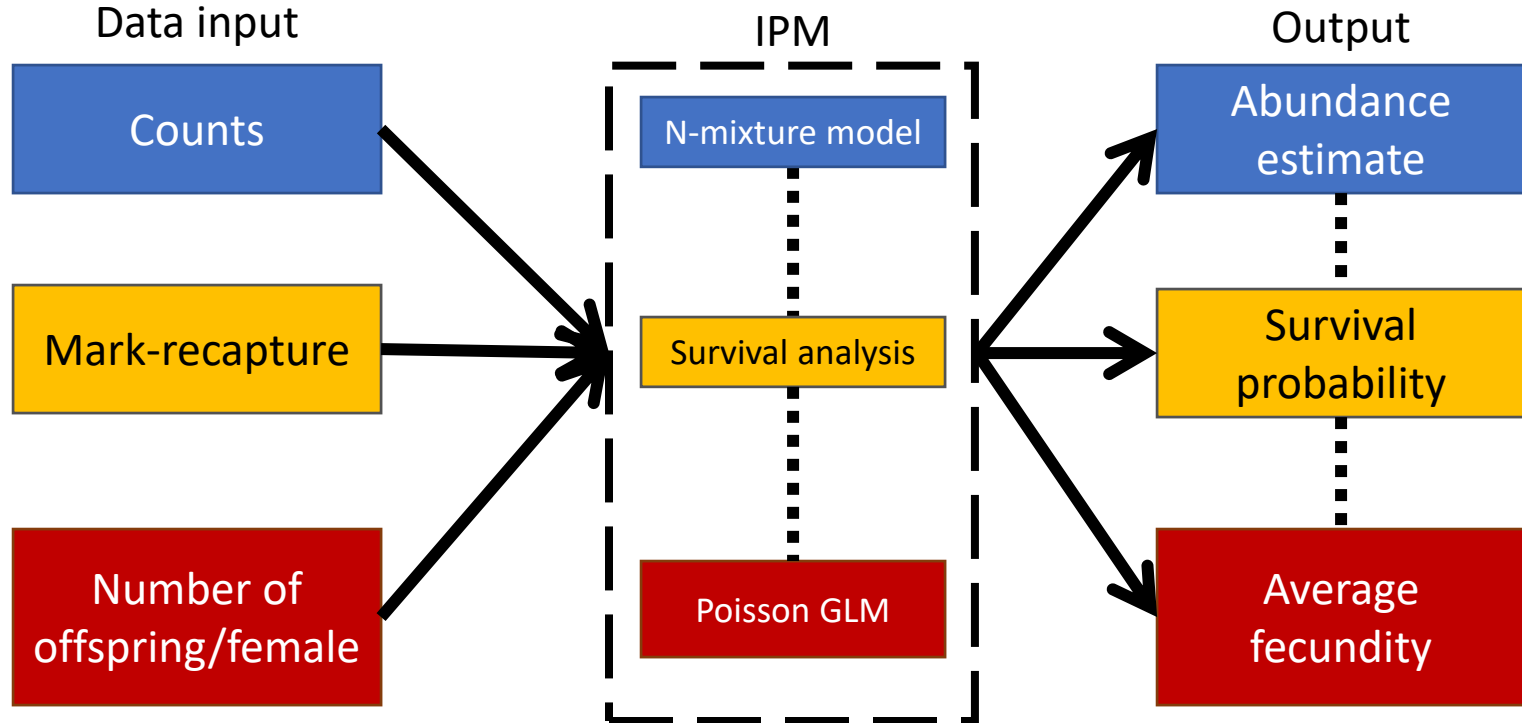
Integrated Population Models (IPMs)

- Relatively new approach to combining all sources of demographic information into one analysis
 - Typically **counts**, **mark-recapture**, and some measure of **fecundity**
- Pros:
 - More precise estimates of demographic rates
 - Can potentially estimate things you don't have explicit data about (usually these things are hard to measure)
 - Immigration/emigration, juvenile survival
 - Can directly project population into the future while propagating all uncertainty
- Cons:
 - More complicated analysis, requires more time/expertise to develop

Non-integrated analysis



Integrated analysis



Change in
population size

λ

$$= \text{births} + \text{immigration} - \text{deaths} - \text{emigration}$$

$$\lambda =$$



Do I need to use an IPM?

- Core assumption = all data are a product of the same underlying population processes
- Most useful when:
 - Individual analyses of different data sources give competing results
 - You want to estimate a demographic parameter without data (e.g. immigration rate)

