Modelling the dynamics of animal populations: does the model fit?

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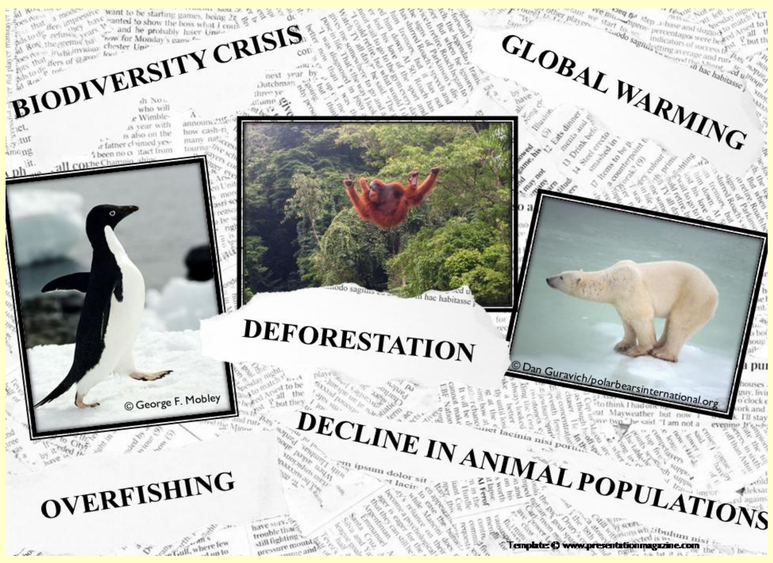


Environmental issues

- Biological knowledge
- Statistical models:
  - **Dynamics of animal populations?**
  - Density estimation?
  - Climate change?
  - ...

Understanding their impact

- Conservation strategies
- New regulations
- Environmental policies
  ...

Decision making

I. Capture-Mark-Recapture (CMR)

- **How to monitor animals?**
  - Camera trapping
  - Genetic sampling
  - **Capture-Mark-Recapture**
  - ...

Capture-Mark-Recapture of slender-billed gulls (*Chroicocephalus genei*)

- **Different levels of information collected**
  - Basic information coding: 0=not seen/1=seen
  - Record of state in which animal is seen: (e.g. colony, health status, breeding status).
  - Information code: 0=not seen/A=seen in state A...
  - State information uncertain: e.g. : health status determined solely by observation of animal's behaviour

t_i / Animals	1	2	3
ID: LZZ3	1	0	1
ID: MC14	0	1	1
...	...		....

1	2	3
A	0	B
0	B	A
...		....

+ Uncertainty in state assignment

Cormack-Jolly-Seber (CJS) model → Multi-state models → Multi-event models

II. Why goodness-of-fit?

- Model parameters: probabilities of capture p, apparent survival Φ, transition between states Ψ
- **Many possible configurations**: parameters dependent on time, state, external covariate (e.g. weather), individual covariate (e.g. gender)

  → **large number of models fitted to 1 dataset**

- Best model generally chosen using information criteria (e.g. :AIC): select **the least worst model among the subset of considered models.**
- Important to **ensure model fits data adequately!**

III. How to assess goodness-of-fit (GOF) for CMR models?

- **Absolute omnibus test statistic**:
  - Is the distance between observed values and expected values under tested model too large?

$$\chi^2 = \sum_{i=1}^{k} \frac{(Observed - Expected)^2}{Expected}$$

  - Indicator of inadequate model fit but no further information

- **Informative goodness-of-fit tests:**
  - **Statistical models are based on assumptions**
  - **Diagnostic GOF tests: specific to model assumptions and provide biological interpretation**

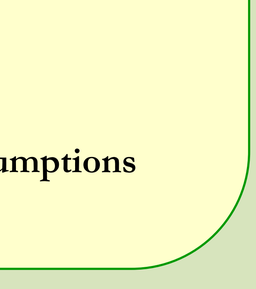
IV. Diagnostic GOF for the CJS model

- Main assumptions: **equal capture probabilities and survival probabilities** for all animals, at each capture occasion.

- **Existing diagnostic GOF tests**

(Pradel et al. (2005), *Animal Biodiversity and Conservation*, **28**(2), 189-204.)
  - Test **2.CT**: detects **trap-dependence**
    Previously captured animals have higher/lower capture probability than others
  - Test **3.SR**: detects **transience**
    Animals passing through the study area, only seen once
  - Test 3.Sm and 2.CL: No straightforward interpretation

- **New diagnostic test for detecting heterogeneity in capture?**
  - Focus: 1 group of animals with high capture
    1 group of animals with low capture
  - At each occasion,
    Less previous captures (PC)=>Less future captures(FC)
    More PC => More FC
  - Method: Goodman-Kruskal's Gamma γ



A: concordant pairs (high PC, high FC)
D: discordant pairs (high PC, low FC)

$$\gamma = \frac{A - D}{A + D}$$

- Some example simulation results

Simulation results (N=2000 animals, % significant tests for 5% level, 10 occasions) Test at occasion 5				
Trap-shyness	Trap-happiness	Transience	Heterogeneity in survival	Heterogeneity in capture
7.6	12.4	1.2	2	100

- Further investigations: other types of heterogeneity?
  global test for all capture occasions?
  smaller sample size (hundreds)?