Mark-recapture studies in goose monitoring

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$$N_{t+1} = N_t S_t + B_t$$

Mark-recapture – an omnibus tool in demography

- 'Recapture' in the broad sense
  - Includes resighting, recovery of dead birds
- The essence: repeated observations of recognizable individuals
- Contains information on:
  - Population size
  - Survival
  - Sometimes recruitment
- Relatively complex statistically

Data requirements and limitations

- Or …
- "How to design a useful mark-recapture program"

# The problem: resighting heterogeneity

- "All [marked] individuals are equally likely to be 'captured'"
- The fundamental assumption of mark-recapture
- Violations are critical and can lead to strong bias
- Very difficult to avoid for social animals!

# In practice: population size

- Need to estimate proportion marked
- Inference to total population – strict assumption
- Assumption:
  - All individuals are equally likely to be caught and marked
  - All marked individuals are equally likely to be observed
  - i.e. marked and unmarked individuals are fully mixed
- Problematic for widely distributed flocking species

In the field …

- Marking
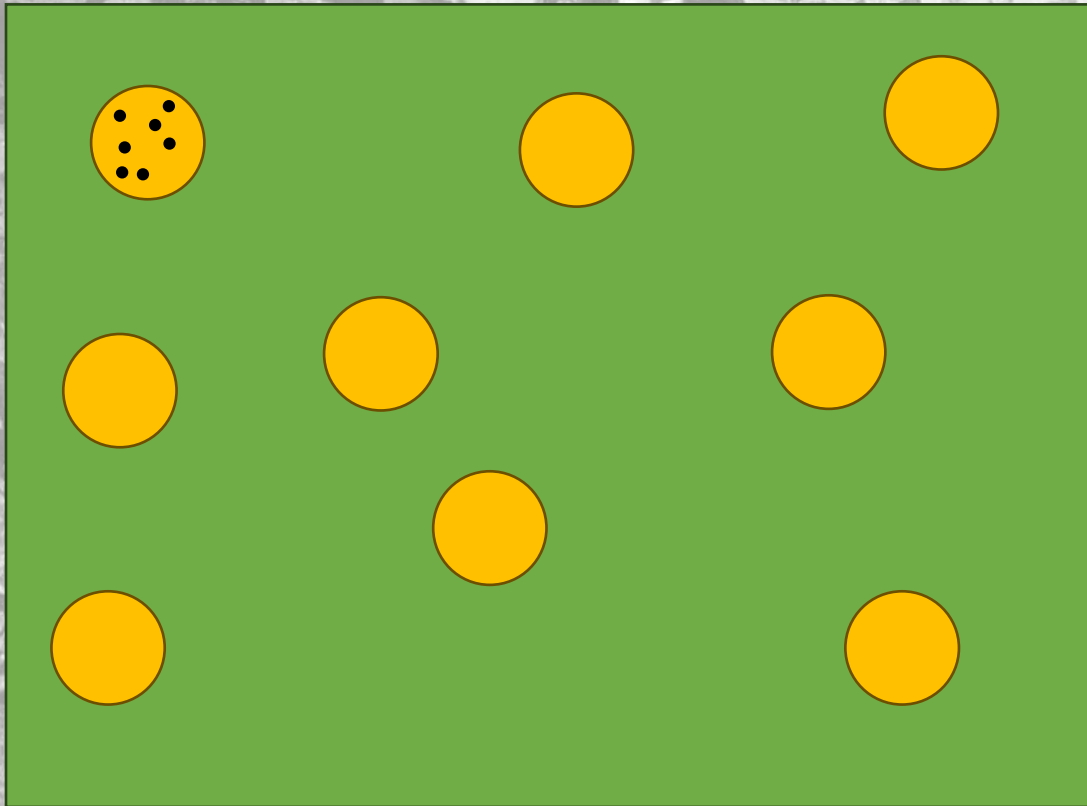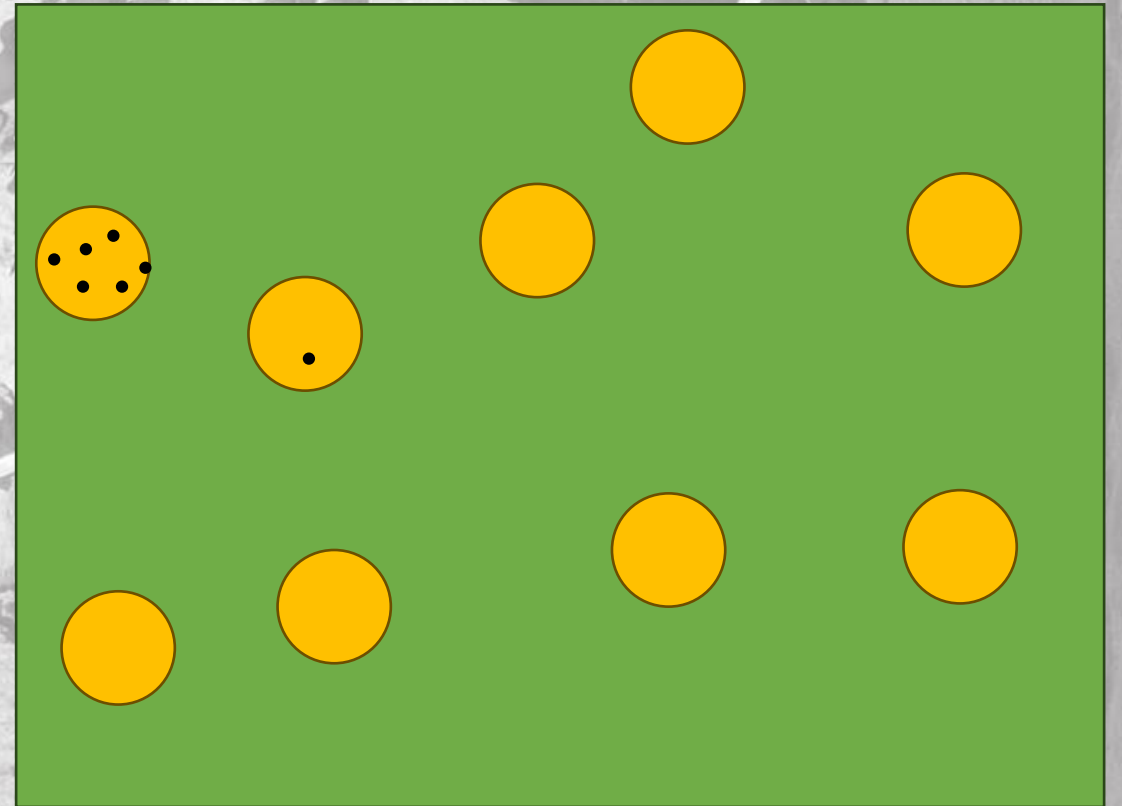
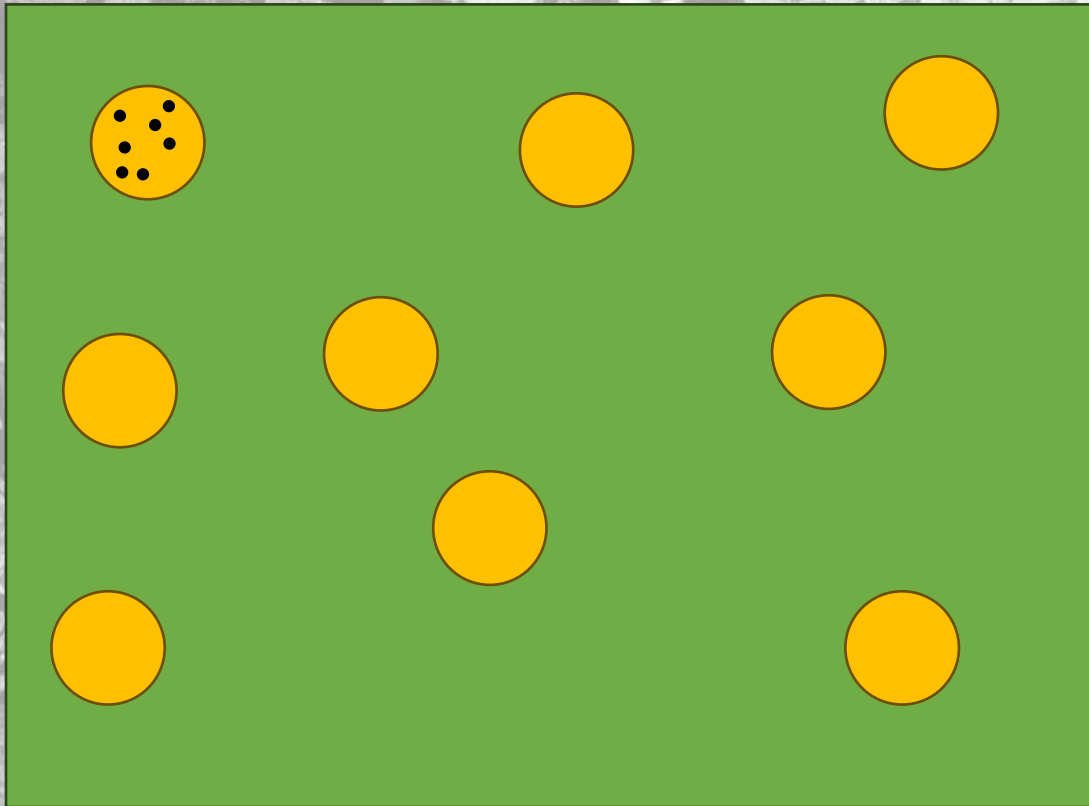- Resighting

Biases, and what to do

- Biases can go both ways:
  - 'Too many' resightings – estimated N too low (most likely)
  - 'Too few' resightings – estimated N too high (less likely)
- Biases can be very severe
- Take home message:
- If you want to estimate N
  - Distribute marking effort – many small catches
  - Distribute resighting effort – better low and uniform than high and local
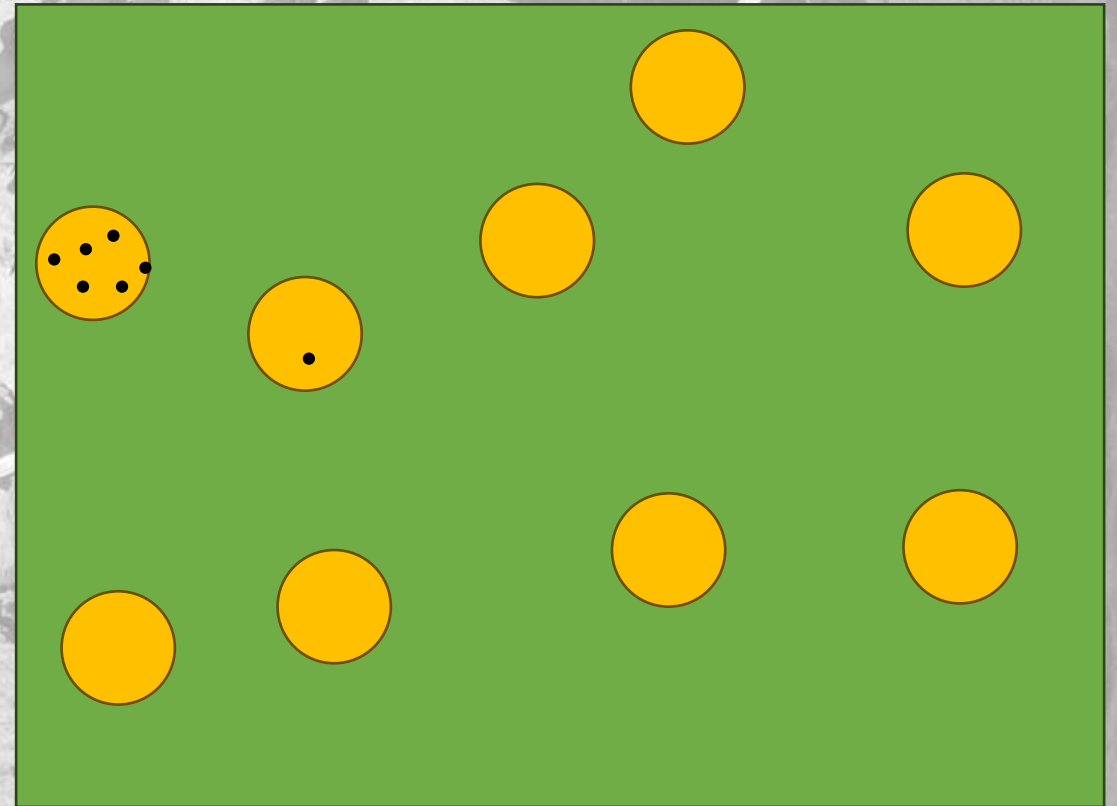- Still very difficult!

In practice: survival

- Need to estimate number of marked birds alive

- Inference to marked sample – relaxed assumption

- Assumption:
  - All marked individuals are equally likely to be observed

- Wish to extrapolate to population?

- Additional assumption:
  - Marked birds are representative of the population

In the field …

- Marking

- Resighting

Biases, and what to do

- Biases is directional:
  - Heterogeneity -> estimated S too low
- Biases is usually moderate
- Take home message:
- If you want to estimate S
  - Distribute marking effort – many small catches, random sampling within flock
  - Distribute resighting effort – better low and uniform than high and local
- Less difficult

Other issues with survival estimation

- Assuming neck collars are used

- Collar loss -> estimated S too low
  - Correction possible, but very laborious

- Impact on survival?
  - Highly debated, may vary among species

- Overall, estimated S is generally too low (at the population level)

- Except if mainly dominant families are caught and marked …

Alternative approach for survival

- Dead recoveries (usually shot birds)
- Fewer biases, but:
  - Marked sample should still be representative
  - Selective hunting risk?
- Lower reporting probability -> larger sample needed
  - Only metal rings needed
- Increase reporting rate
  - E.g. through rewards – common in North America