

An aerial photograph of a large colony of geese, likely greylag geese, on a rocky island. The geese are densely packed across the terrain, which consists of large, light-colored rocks and patches of low-lying vegetation. The overall scene is captured in a monochromatic, slightly desaturated color palette, emphasizing the textures of the rocks and the patterns of the bird colony.

Mark-recapture studies in goose monitoring

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A high-angle photograph of a vast colony of seabirds, likely terns, nesting on a rocky island. The birds are densely packed across the terrain, which consists of light-colored, jagged rocks and patches of sand. The birds have dark wings and backs with white underparts. The overall scene is a natural, undisturbed avian habitat.
$$N_{t+1} = N_t S_t + B_t$$

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

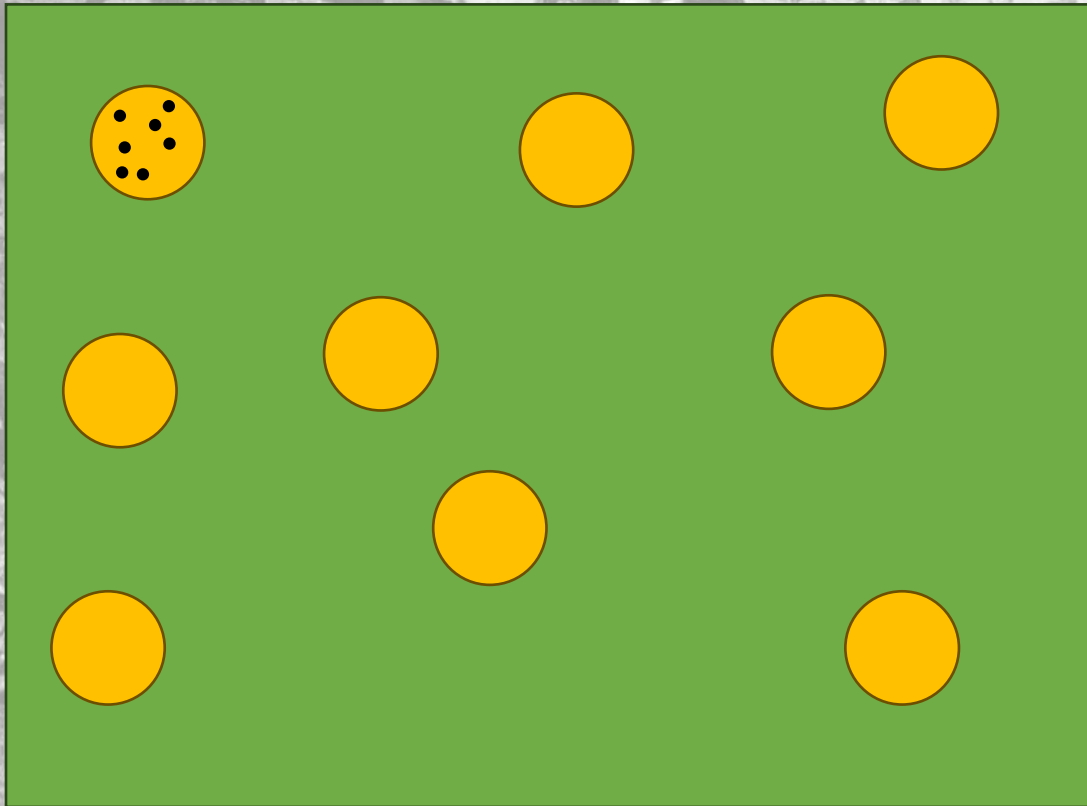
- “All [marked] individuals are equally likely to be ‘captured’”
- The fundamental assumption of mark-recapture
- Violations are critical and can lead to strong bias
- Very difficult to avoid for social animals!

In practice: population size

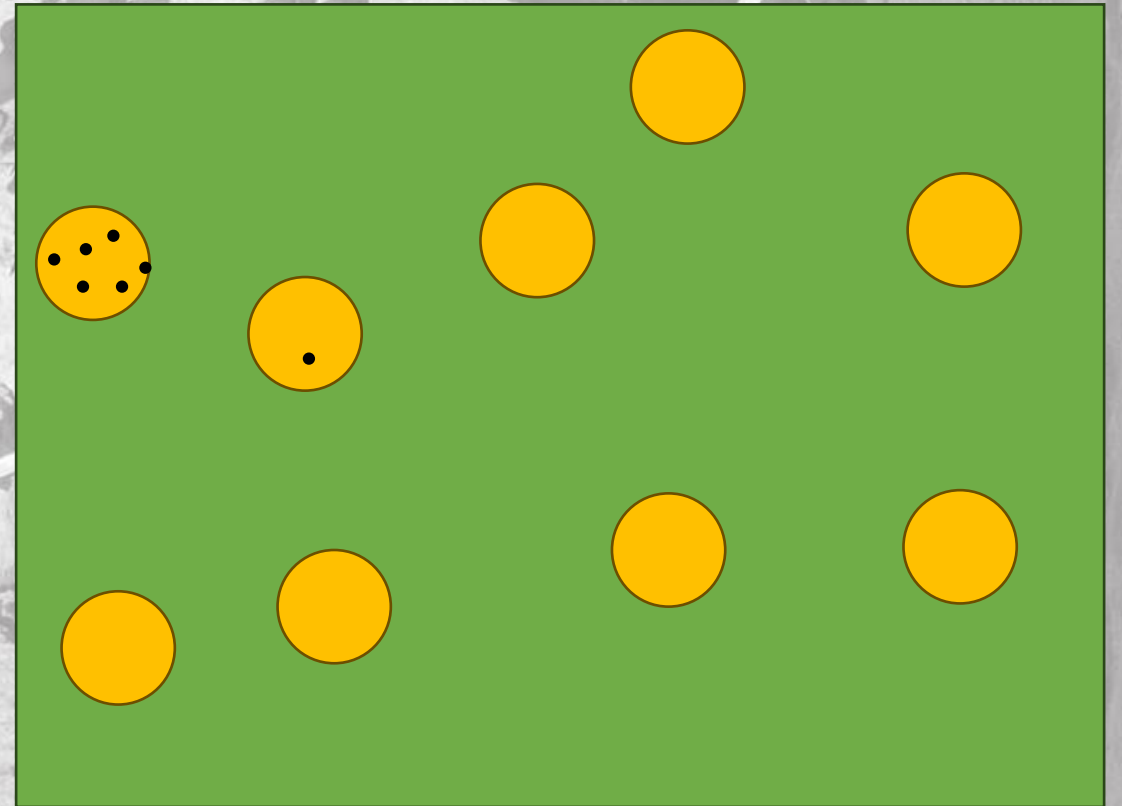
- Need to estimate proportion marked
- Inference to total population – strict assumption
- Assumption:
 - All individuals are equally likely to be caught and marked
 - All marked individuals are equally likely to be observed
 - i.e. marked and unmarked individuals are fully mixed
- Problematic for widely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

In the field ...

- Marking



- Resighting



Biases, and what to do

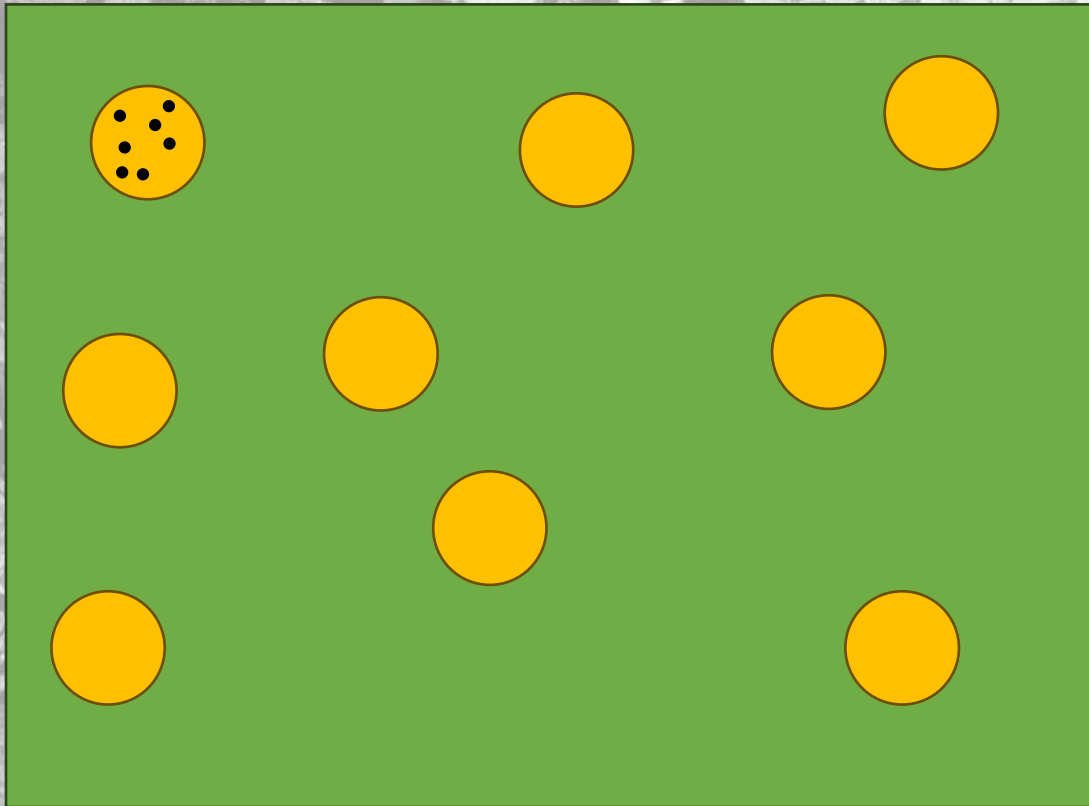
- Biases can go both ways:
 - ‘Too many’ resightings – estimated N too low (most likely)
 - ‘Too few’ resightings – estimated N too high (less likely)
- Biases can be very severe
- Take home message:
- If you want to estimate N
 - Distribute marking effort – many small catches
 - Distribute resighting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

In practice: survival

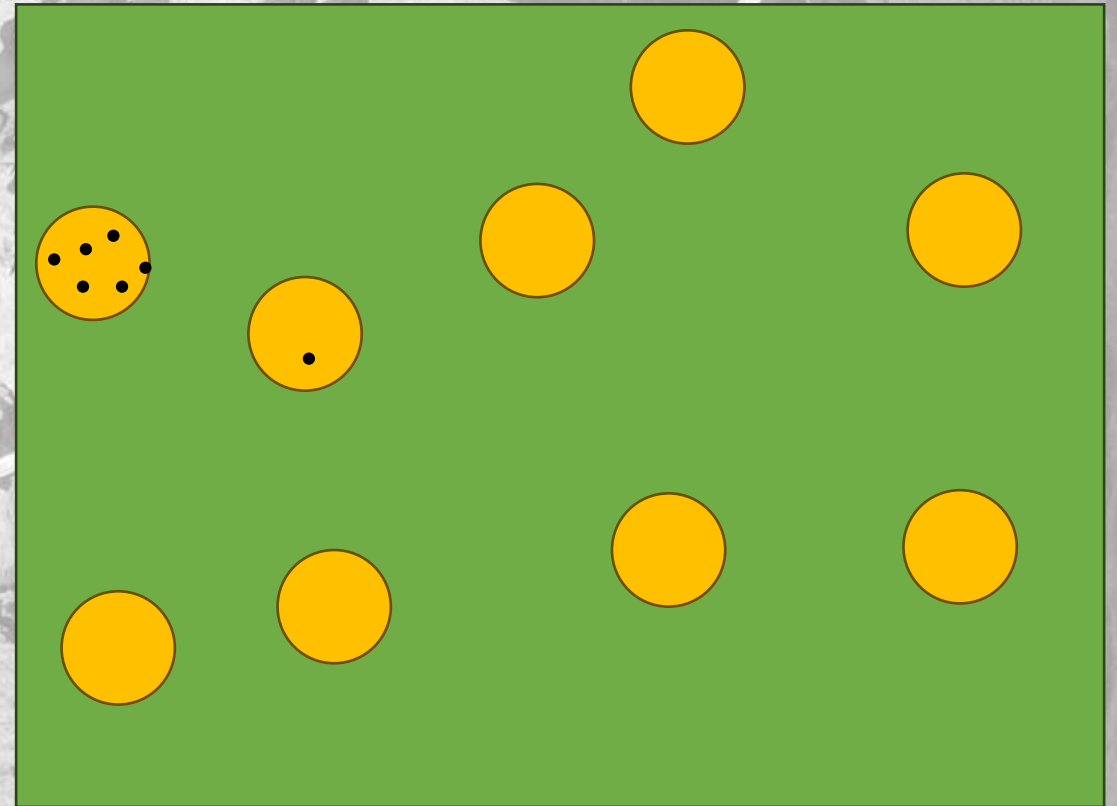
- Need to estimate number of marked birds alive
- Inference to marked sample – relaxed assumption
- Assumption:
 - All marked individuals are equally likely to be observed
- Wish to extrapolate to population?
- Additional assumption:
 - Marked birds are representative of the population

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