Detection Probability Basics and Survey Design Considerations

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Outline

I. Detection probability and modern point count methods
   a. The importance of detection probability
   b. Components of detection probability
   c. Methods that account for detection probability
      a. Method assumptions

II. Case studies
   a. Separating detection probability components
   b. Accounting for false positives
   c. Accounting for prior information

III. Conclusions

Point Counts

- Point count
  - Common and simple sampling method
  - Number of birds seen or heard (C)
- What is the relationship between C and the bird population (N)?

C = N?

C = a constant *but unknown* fraction of N?

Detection Probability

- The probability that a bird within the point count area is visually/audibly detected.

$$\hat{N} = C/\hat{P}$$

Where:

$\hat{N}$ = the population estimate

C = number of birds counted

$\hat{P}$ = the estimated probability that a bird is detected

Components of Detection Probability

$$\hat{P} = P_p P_a P_d$$

1) P_p = the probability that a bird associated with the point count area is present during the point count
2) P_a = the probability a bird that is present in the point count area is available for detection
3) P_d = the probability a bird that is present and available is actually detected

Multiple Observers

- Independent double-observer
  - Three potential detection histories
  - Requires reconciliation
- Dependent double-observer
  - Two potential detection histories
  - Does not require reconciliation
- Estimate: P_d only

1,1
1,0
0,1

1,1
0,1

Time-of-Detection

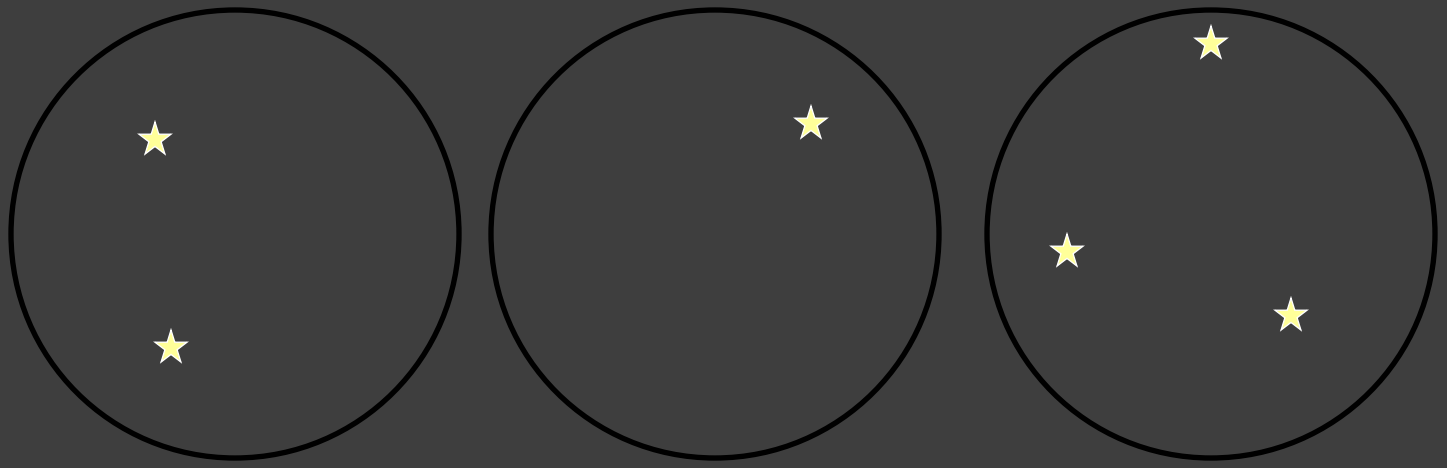
- Time-of-detection
  - Point count divided into several intervals
  - “Capture-recapture” data
- Estimate: $P_a P_d$ only

Interval 1 = Blue
Interval 2 = Green
Interval 3 = Black
Interval 4 = Red

TOD Detection History (1,0,1,0)

Repeated Visits

- Two or more visits to a point count location
- Estimate: $P_p P_a P_d$



Site History (2,1,3)

Common Method Assumptions

- Closed population
  - Mobility of target species
    - Duration of count
  - Duration between visits (repeated visits)
- Detection probability is constant among individual birds
  - Can be modeled with time-of-detection
- No double counting or misidentification
- Detection probability components not estimated are equal to 1 or constant

Methods Overview

- Some methods are statistically superior
  - P_d vs P_aP_d vs $P_pP_aP_d$
- Tradeoff between statistics, personnel acceptance of methods, budget constraints, etc.
- Combined methods
  - Allows determination of individual detection components
  - More informed study design

Case Study 1 - Introduction

Riddle et al. 2010*

- Point count survey
  - Northern bobwhite in coastal plains of North Carolina
- Combined methods to estimate P_a and P_d
  - Time-of-detection (P_aP_d)
    - 4 2.5 minute intervals
  - Dependent double-observer (P_d)
    - Determine detection probability estimates of P_a and P_d
      - $P_aP_d / P_d = P_a$

**Separating Components of the Detection Process with Combined Methods: An Example with Northern Bobwhite*

Case Study 1 - Results

– P_a (0.650) was more limiting than P_d (0.799)
  - Bobwhites were detected 80% of the time when available
  - 60% of individuals were available in a 2.5 minute interval
  - During a ten minute count >90% bobwhite were available ≥ 1 time

Case Study 1 - Implications

- Tradeoff between number of surveyors and survey length
  - May only need one observer and a longer duration survey
    - Save on personnel costs

Case Study 2 - Introduction

(McClintock et al. 2010)*

- Simulated frog survey using remote speakers
- Expert observers provided a list of 11 potential species
  - 6 species calls were never broadcasted
- Determine impact
  - False negative error (not detecting an available species)
    - Common and can be accounted for
  - False positive errors (detecting a species that is not present)
    - Generally thought to be less common and of less concern

* Unmodeled Observation Error Induces Bias When Inferring Patterns and Dynamics of Species Occurrence Via Aural Detection

Case Study 2 - Results

- False positive errors led to misleading inferences about occupancy
  - Overestimation of occupancy, colonization rate, and extinction rate
- Mentioning a species may influence likelihood of false positive error
  - 5 of 6 species not present were detected
  - Increasing distance = more false positive error

Case Study 2 - Implications

- Increasing distance leads to a greater likelihood of false positive error
  - Use a limited radius
- Call intensity
  - False positives errors are less likely as call intensity increases

Case Study 3 - Introduction

Riddle et al. 2010*

- Human behavior is influenced by expectation and prior information
  - Problematic for repeated detections
  - May result in increased probability of redetection (behavioral “trap happy” response)
    - Underestimation of abundance
- Data from 3 studies
  - Determine the effect of prior information

*Effects of Prior Detections On Estimates of Detection Probability, Abundance, and Occupancy

Case Study 3 - Results

- Top models allowed for increased redetection probability.
  - Increase in redetection probability of 29%-68%

Case Study 3 - Implications

- Repeated visits
  - Ideally rotate surveyors
    - Avoid discussing survey results with other observers
  - If not practical, maximize time between visits
- Time-of-detection
  - Plot initial and subsequent detections or run a behavioral model

Conclusion

- Detection probability is a multifaceted issue
  - No silver bullet
    - Different surveys have different needs
  - Managers know their study subjects best
    - Management objectives, knowledge of species, and current and future funding are critical
    - Consult a statistician
    - Manager stays in the driver seat
    - Determine how these new methods can help meet objectives rather than driving the study

Questions?

$\hat{P}$