Aerial Survey

What is our objective?
- Gut feeling for herd condition?
- Index of abundance?
- Valid, consistent, repeatable estimates of abundance and condition?

Absolute Abundance
- Total count over whole area
- Total counts on sample plots

Total counts on sample plots
- Plots can be quadrats, strip transects, or irregular shaped areas
- Critical assumption is that every animal is observed and counted once

Sample Units
- Delineate area
- Apply survey sampling methods to design an appropriate sample
- Test assumptions and remove bias if necessary

Common Sample Designs
- Simple Random
- Stratified Random
- Cluster
- Systematic
Removing Bias from Sample Counts

- Correction Factor (Ratio)
- Mark Recapture
- Sightability Model

Removing Bias: Correction Factor

- Use depends upon assumption of a constant factor under highly variable conditions.

Correction Factor

- One drainage to next has different cover
- Use of cover varies from flight to flight
- Size of groups vary continuously
Removing Bias: Mark-Recapture

- Well established statistical basis
- Questionable assumptions in most aerial survey conditions
- Extremely costly in time and resources because must capture and mark animals each time

Removing Bias: Sightability Model

- Adaptable to a variety of conditions
- Cost efficient
- Not applicable if visibility is very low

Sightability Model

- Mark elk (deer, sheep, etc.) groups with radio-collars
- Fly aerial survey
- Determine which groups seen and which groups missed
- Depends on group size, tree & shrub cover, snow cover, weather, observers, type of helicopter, etc.

Simple Application

- Suppose we determine that 1/3 of groups are detected (p=0.33)
- Then, if see 50, actually 150 present
- How? Correction Factor (CF)= 1/p
  - CF= 1/0.33 = 3.0
  - \( N = N_{\text{obs}} \times CF = 50 \times 3.0 = 150 \)

Application to a Sample Unit

- Correct each group detected for its probability of detection (visibility)
- Sum all corrected groups in a sample unit for an unbiased estimate of actual number of animals present

Application to a Herd Unit

- Calculate means, ratios, proportions, etc. according to survey design
- Calculate variances and confidence intervals
Sightability Model

- Build a sightability model using logistic regression
  - \[ p = \frac{e^{\mu}}{1+e^{\mu}} \]
  - where \( \mu = a + b_1 X_1 - b_2 X_2 \)
  - e.g. \( X_1 \) = group size, \( X_2 \) = veg. cover

Lochsa River - Unit 12

- Traditional Sightability Counts

Estimate of Total Numbers

- \( m_{ik} \) = number of animals in group \( i \) in land unit \( k \)
- \( CF_{ik} \) = correction factor for group \( i \) in land unit \( k \)
- \( M_k = \sum m_{ik} CF_{ik} \)
- Average = \( \sum M_k / \text{No. land units sampled} \)
- Total = Average * Total no. land units

How good is estimate?

- Variance of Total = Sampling Variance + Sightability Variance + Model Variance

- Sampling Variance = Variation from one geographic unit sampled to another
  - \( = \sigma^2 \)
How good is estimate?

- Sightability Variance = Variation (or error) from not seeing all the animals
  - proportional to $CF^2$

- Model Variance = variance of parameters in model (betas)
  - proportional to $e^{(Variance-Covariance)}$

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Lochsa River - Unit 12

1985 Estimate of total elk = 4775
Sampling Variance = 59733
Sightability Variance = 16868
Model Variance = 825
Total Variance = 77426
90% Bound = 458

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Herd Composition

- Cows 2852 (269)
- Bulls 968 (166)
- Calves 857 (105)
- Bulls per 100 Cows 34 (6.4)
- Calves per 100 Cows 30 (5.4)

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Northern Yellowstone Elk

- Surveyed in 1 day with 3 Super Cubs
- Survey of whole range (all units)
- Developed sightability model in 80's
  - $\mu = 0.969 + 0.0369 \text{ Group Size} + 0.540 \text{ Vegetation Cover} + 1.701 \text{ Activity}$

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Northern Yellowstone Elk

1988
1989
1990
1991

AERIAL SURVEY PROGRAM

- All calculations easily performed
- Variety of sightability models
- See Unsworth et al 1994