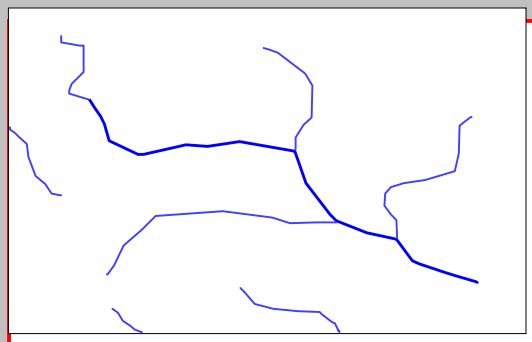
Aerial Survey

Aerial Surveys for Large Mammals

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

Absolute Abundance

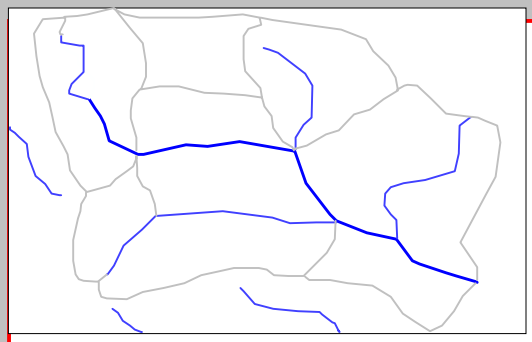
- Total count over whole area
- Total counts on sample plots



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



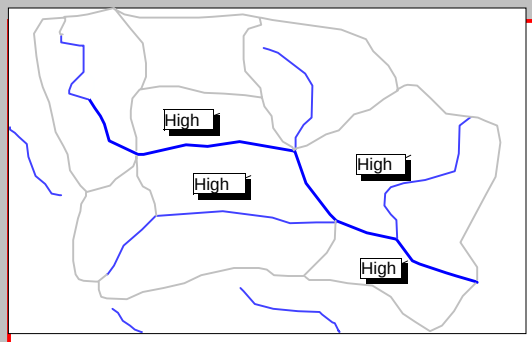
Total counts on sample plots - Application

- 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

Sample Design



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.

Sightability Model

- Keep some factors constant
- Develop a sightability model for other factors
- Use sightability model to correct for factors which we cannot control
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Sightability Model

- Apply same model in other areas too if same type of helicopter and approach used and original model covered appropriate conditions in terms of veg cover, snow, animal behavior, etc.
- We've had original crews train new crews to insure that model still applies.

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
- $N = N_{obs} * CF = 50 * 3.0 = 150$

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

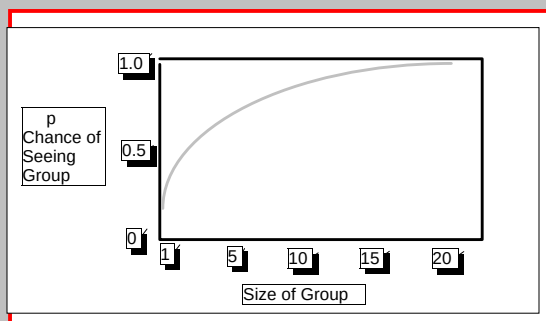
Application to a Herd Unit

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

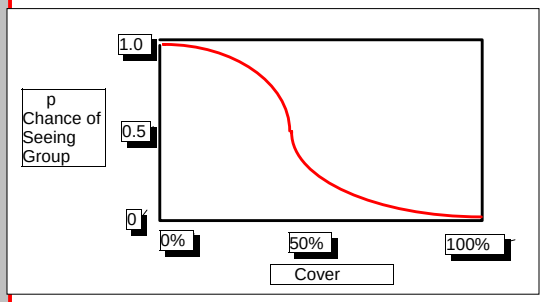
Sightability Model

- *Build a sightability model using logistic regression*
- $p = e^{\mu} / 1+e^{\mu}$
- *where* $\mu = a+b_1X_1 - b_2X_2$
- *e.g.* X_1 *= group size,* X_2 *= veg. cover*

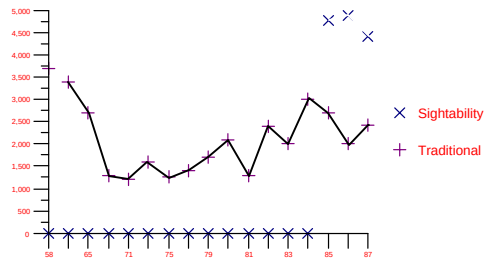
Sightability Model



Sightability Model



Lochsa River - Unit 12



Lochsa River - Unit 12

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*
- $M_k = \Sigma\, m_{ik}\ CF_{ik}$
- *Average =* ΣM_k */ No. land units sampled*
- *Total = Average * Total no. land units*

How good is estimate?

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

How good is estimate?

- *Sampling Variance = Variation from one geographic unit sampled to another*
- $= S^2$

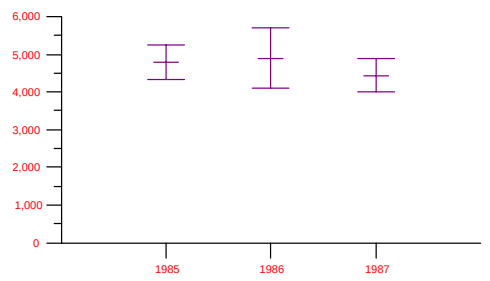
How good is estimate?

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

How good is estimate?

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

Lochsa River - Unit 12



Sources of Variation

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

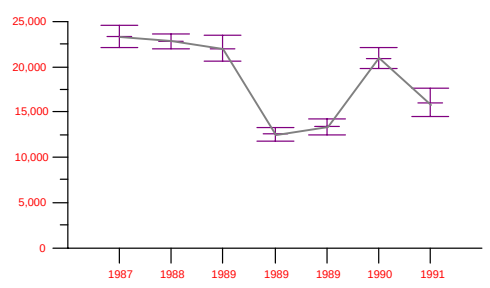
Herd Composition

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

Northern Yellowstone Elk

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

Northern Yellowstone Elk



AERIAL SURVEY PROGRAM

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