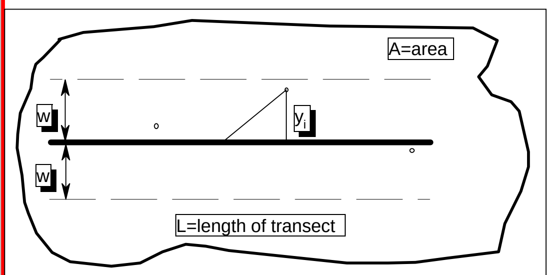
Line Transect/Point Count

Line Transect

- *Line transects and point counts are used widely to count animals.*
- *They are variants of the same approach.*
- *We will begin with transects which are somewhat simpler to describe.*

Line Transect

- *Typical Layout:*



Line Transect

- *D= density = N / A*
- *= (number counted)/(area covered)*
- *= n/2Lw (or = n/kπr^2)*
- *n= number of animals counted*
- *L=length of the transect*
- *(k = no. points counted)*
- *w = effective width*
- *(r = effective radius)*

Field Experiment

- *Test these ideas with a known N*
- *Old Arboretum*
- *Place birds in a known area (A)*
- *Estimate their density with*
- *Line transects and point counts*

Field Exercise

- *Apply line transects and point counts to estimating the number of birds in parks and residential areas in Moscow*
- *Each person walk at least 2 blocks or (200 m) each in parks and in residential areas or do atleast 4 point counts in each area*

Field Exercise

- *Minimum count required: 20 groups of birds in each “habitat”*
- *Note: For birds (or other animals) in groups record each group as a single observation. The density estimate will be for groups of birds which you would multiply by average group size to estimate birds per unit area (hectare).*

Assumptions:

- *1. Animals are randomly and independently distributed over the population area.*
- *2. The sighting of one animal is independent of the sighting of another.*
- *3.No animal is counted more than once.*

Assumptions:

- 4. Animals are detected at their intial location prior to disturbance by the observer.
- 5. The response behavior of the population as a whole does not change during the course of the census.
- 6. The animals are homogeneous with regard to their response behavior, regardless of sex, age, etc.

Assumptions:

- 7. The probability of an animal being seen, given that it is a right-angle distance from the line transect path (irrespective of which side of the path it is on), is a simple function g(y) of y, such that g(0)=1 (i.e. probability 1 of seeing an animal on the path is 1.0).

Distance Sampling: Key References

- Seber, G.A.F. 1973. The Estimation of Animal Abundance. Hafner, NY.
- Buckland, S.T., D.R. Anderson, K.P. Burnham, J.L. Laake D. L. Borchers and L. Thomas. 2001. Introduction to Distance Sampling: Estimating Abundance of Biological Populations. Oxford University Press, Oxford.

Seber (1973)

- Detection Curve = g(y)
- g(y)= Prob.(animal seen |animal at y)
- Observed Detection Function = f(y)
- f(y)=Prob.(animal at y | animal seen)
- If set w = Integral of g(y) dy
- Then f(y) = g(y)/w

Examples of f(y)=detections

Density Estimate

- How do we estimate density?
- Old approach:
  - Make an assumption about g(y)
  - Derive an estimator
  - Find parametiers
  - calculate it

New Approach to Density

- Find a function which fits f(y) well
- Then, assuming that all animals directly on the line (y=0) are detected
- g(0) = 1
- From f(y) = g(y)/w
- f(0) = g(0)/w = 1/w
- So Estimate of w = 1/f(0)

Density Estimate

- D^ = n / 2Lw
- D^ = n f(o) / 2L
- So we must find a function f(y) which fits the observed detection distance curve well and then determine f(0)
- Note: In Lecture Outline notes on web w is symbolized by a

Detection Curve

- What is a good model for f(y)?
- 30+ proposed and used
- Buckland et al. 2001 criteria
  - a. Model robustness (flexible)
  - b. Pooling robustness
  - c. Shape criterion (shoulder)
  - d. Efficiency (small variance)

Modelling g(y)

- 2 step process:
- 1. Select a "key function" as a starting point
- 2. A flexible form (a "series expansion" is used to adjust the key function (using 1-2 parameters) to improve fit of model to distance data.

Key functions

- Uniform
  - 1/w
- Half-normal
  - $e^{-y^2/2s^2}$
- Hazard-rate
  - $1-e^{-(y/s)^{-b}}$

Series Expansion

- Cosine
- Simple polynomial
- Hermite polynomial

Truncation

- Often required to find a good model and get a good fit (outliers).
- Recommend truncating observations beyond distance at which prob. detection falls below 10%.

Likelihood Ratio Test

- Use this to judge requirement for adjustment terms to a key function
- Allows evaluating whether addition of m_2 terms to m_1 already in model significantly improves it.
  - H_0: Model w/ m_1 adjustments is true model
  - H_a: Model w/ m_1+m_2 adjustments is true
- $X^2 = -2 \ln (L_1 / L_2)$
  - where L_1 and L_2 are maximum likelihood functions for models 1 & 2

Sequential Approach

- Fit a key function, then fit a low order adjustment term.
- If adjustment improves model fit significantly,
- then test next order adjustment, etc.
- Default approach in DISTANCE
- Buckland et al. recommend α = .15 to increase power.

Akaike's Information Criterion

- Optimization approach
- AIC = -2 ln (L) + 2q
  - where ln (L) is log-likelihood function evaluated at the max. likelihood estimates of model parameters (q= no. of parameters)
- Model with lowest AIC is selected

Goodness of fit

- *Useful tool for model selection*
- *Compares no. of detections in each distance interval to expected no. under fitted model.*

POVCP

- *Paired Observer Varible Circular Plot*
- *Developed by Kissling and Garton (In Auk, July 2006)*
- *Combines distance estimation approach with double observer estimation of probability of detection for objects at center of plot.*

POVCP

- *Two observers stand at plot center and independently record every bird and distance as well as any bird movements on a simple plot map.*
- *After 8 minute count observers compare maps. [Observers get feedback, i.e. must stay sharp and learn from each other.]*
- *At end of day each observer enters their observations into a database which notes birds seen by both or not*

POVCP

- *Each observer's data first analyzed with DISTANCE to determine at what distance detection probability falls below 1.0 (approx. perfect detection distance).*
- *Each observer's detections and misses are analyzed and modelled with logistic regression to estimate each observer's prob. of detection at y=0.0, plot center (g(0)) w/ covariates(rain, veg type, etc.).*

POVCP

- *Correction factors are calculated from* $\theta=1/g(0)$ *for each observer.*
- Each observers count at a point is converted to a density estimate from $D=(\Sigma\theta f(0)n)/2\pi$
- *A single density estimate for each count is then calculated by averaging the 2 observers density estimates at that point incorporating each observer's effective area and their correction factor.*

POVCP

- *We applied this to surveys of beach strands left from timber harvest in SE Alaska in 2001 and 2002.*
- *Comparing estimates to surveys analyzed by 4 other standard methods, the estimates were remarkably more precise and showed that other standard methods are biased low because of birds missed close to the plot center.*

POVCP

- *Detection probabilities at plot center varied by observers and by bird species from .61 to 1.0 for Hermit Thrush, .83 to .99 for Winter Wren, .8 to .95 for Pacific-slope Flycatcher. etc.*
- *Density estimates varied for Winter Wrens from 0.84 birds/ha by point counts (no distances used) to 1.70 by VCP to 1.83 by POVCP.*