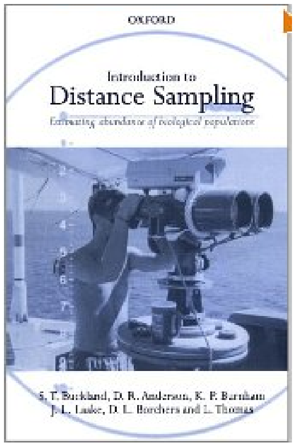
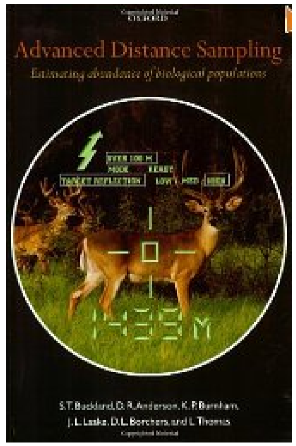
Distance sampling





Estimating abundance

Abundance estimation is often accomplished using this equation:

$$\hat{N} = \frac{n}{\hat{p}}$$

- N is abundance (population size)
- n is the number of individuals detected
- $\hat{p}$ is an estimate of detection probability: The probability of detecting an individual

Most methods differ in how they estimate p

Estimating abundance

Challenges

- Detection probability is rarely constant
- It is a function of:
  - Age
  - Sex
  - Habitat
  - Distance

Distance Sampling

Basic idea

- p_i is the probability of detecting individual i at distance x_i.
- Since every individual in the population has a different detection probability, we replace p with the *average* detection probability: $\bar{p}$
- The equation is now:

$$\hat{N} = \frac{n}{\hat{\bar{p}}}$$

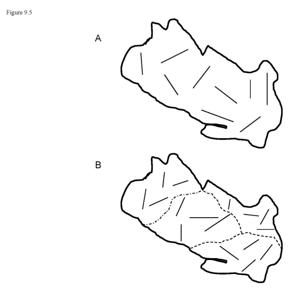
Advantages of distance sampling

- Population size can be estimated from a single survey
- Explicit link between population size and density

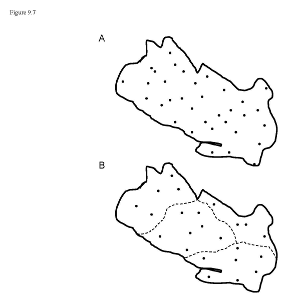
Design

- Randomly place line transects or points throughout the study area
- Record the distance to each animal detected

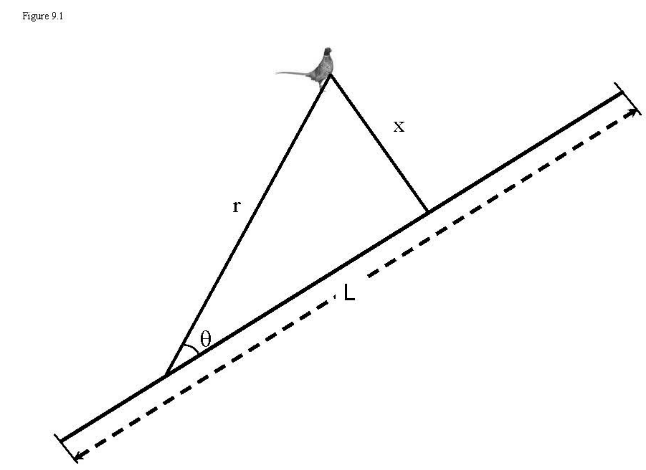
Line transects



Point transects

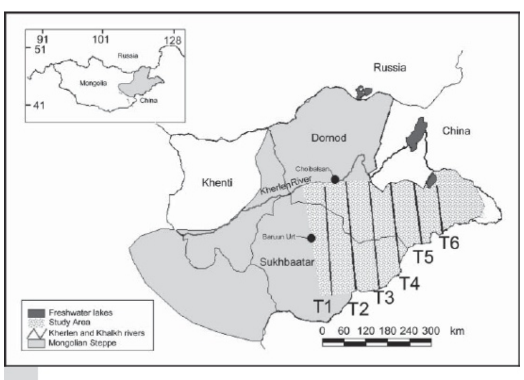


Line transects



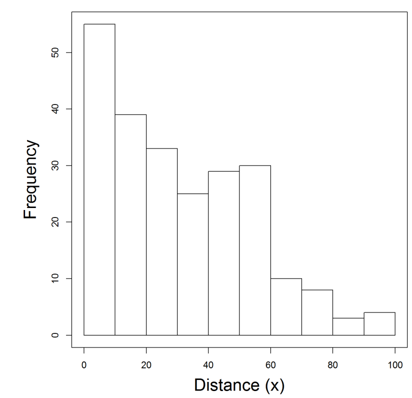
In line transect sampling, it is common to record the radial distance and bearing, rather than the perpendicular distance. However, the analysis must be conducted on the perpendicular distance data.

Real design



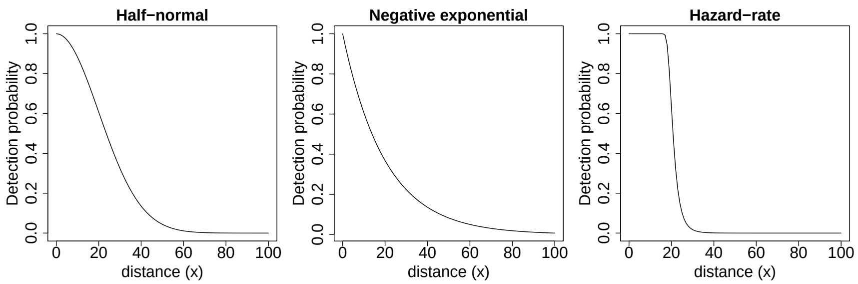
Line transects

Data	
Animal	Distance (x)
1	4.4
2	25.3
3	41.8
4	3.1
5	78.5
⋮	
n	4.4

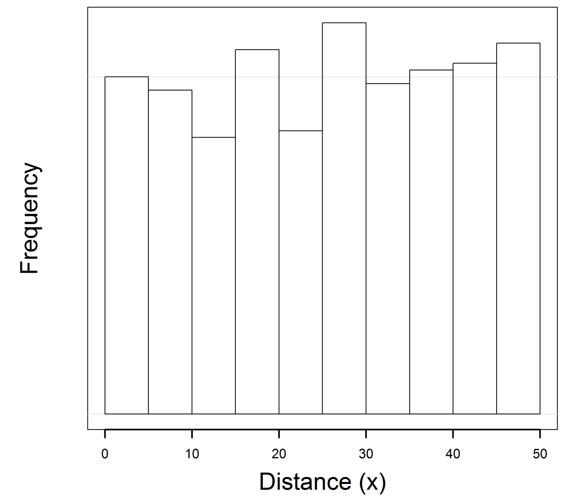


Estimating $\bar{p}$, average detection probability

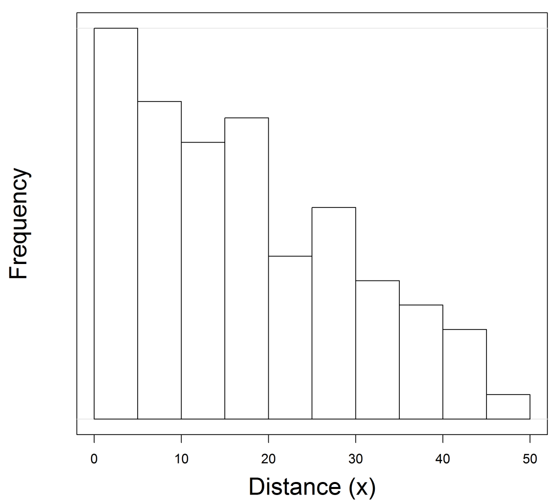
- Fit a detection function, $g(x)$, to the data
  - Assume $g(0) = 1$
  - Half-normal, hazard-rate, negative exponential, etc...
- Assume individuals are "uniformly" distributed with respect to the transect (valid under random sampling)
- $\bar{p}$ is then the proportion of the area under the detection function.



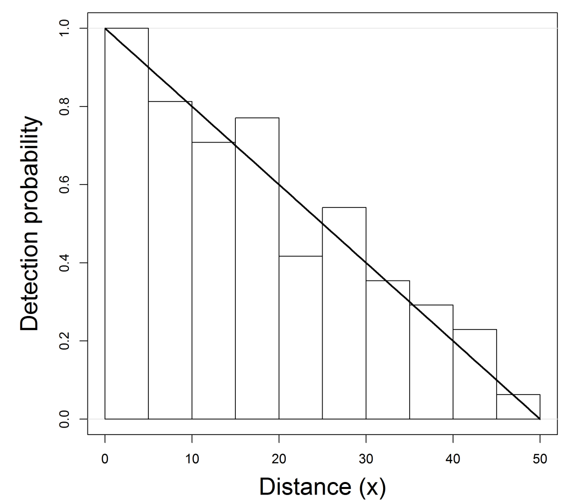
Computing $\bar{p}$, average detection probability



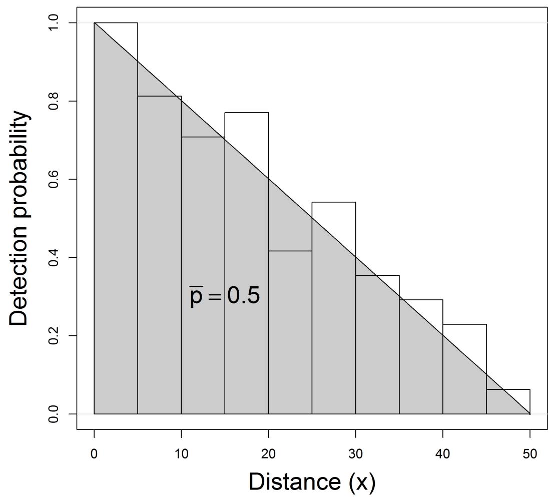
Computing $\bar{p}$, average detection probability



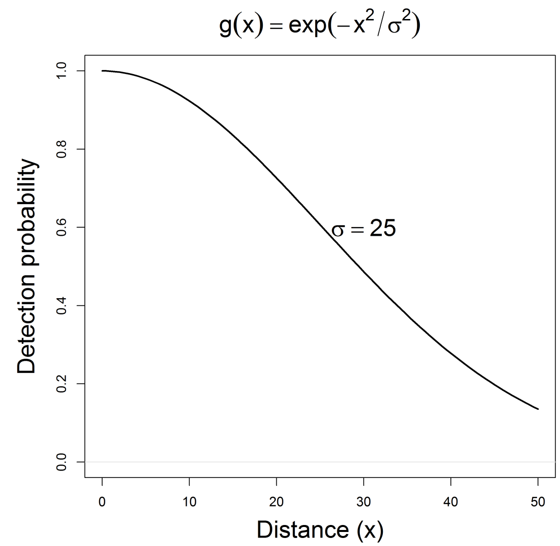
Computing $\bar{p}$, average detection probability



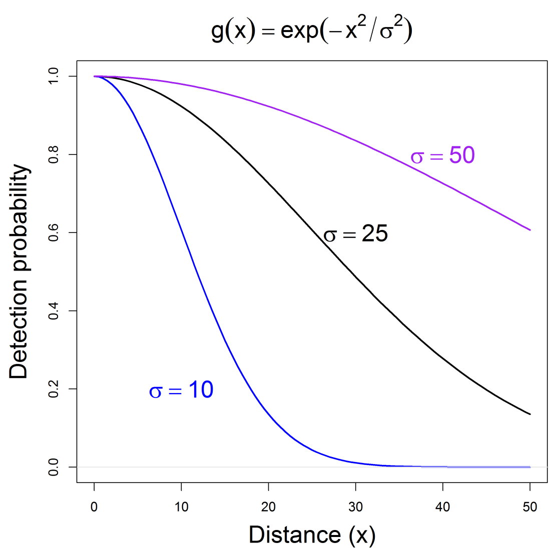
Computing $\bar{p}$, average detection probability



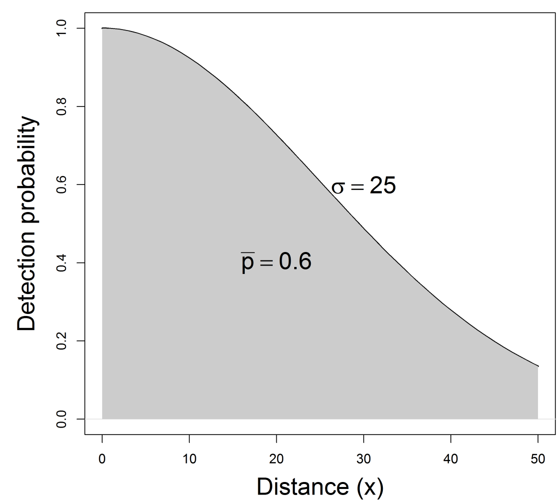
Computing $\bar{p}$, average detection probability



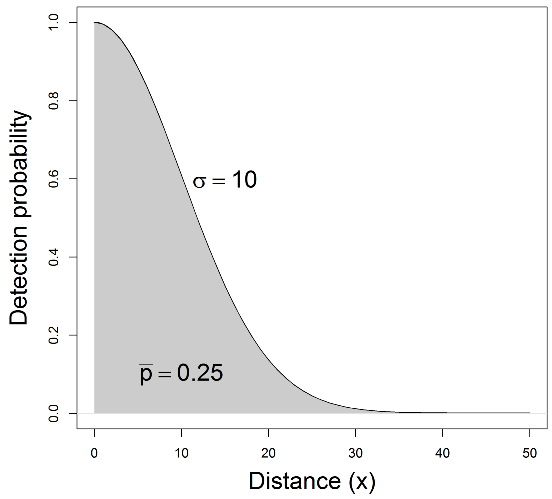
Computing $\bar{p}$, average detection probability



Computing $\bar{p}$, average detection probability



Computing $\bar{p}$, average detection probability



Assumptions

(1) Animals on the line are detected with certainty (i.e., $p = 1$ when distance=0).

(2) Animals do not move during the survey

(3) Distance is measured accurately

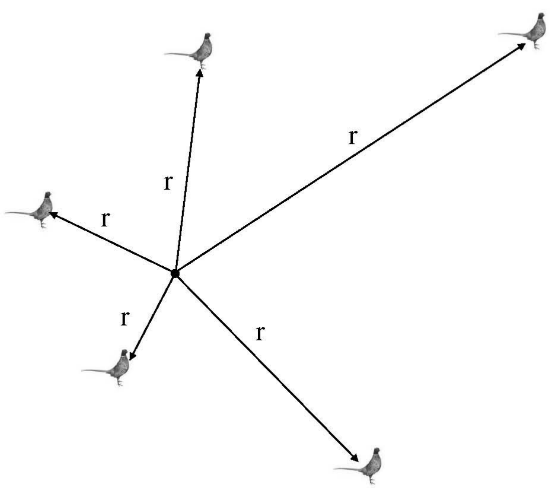
(4) Transect lines are placed randomly with respect to the animals

- This ensures that individuals will be uniformly distributed with respect to the transect

(5) Detections (of individuals or groups) are independent of one another

Point transects

Figure 9.6



Differences between point vs line transects

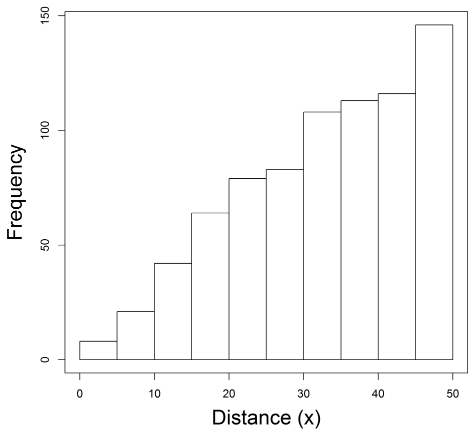
We still use the same type of detection function (half-normal, hazard, etc.)

We don't expect a "flat" histogram of distances when $\bar{p} = 1$. Why?

Because there is a slim chance of an individual being close to point

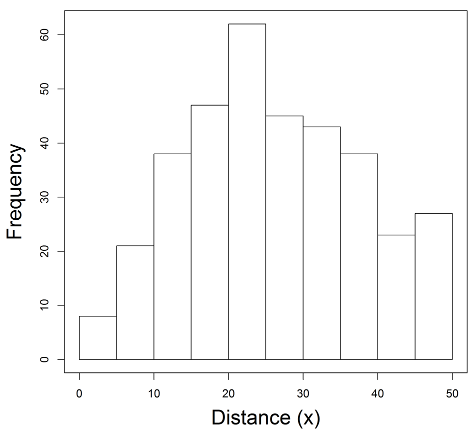
Point Transects. $\bar{p} = 1$

When average detection probability is 1, the histogram of distances will look like this because there is more area (and hence more individuals) far from the point.



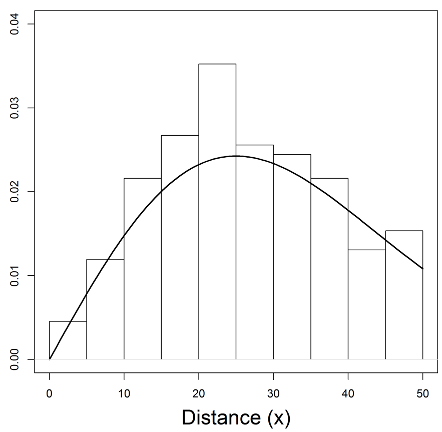
Point Transects. $\bar{p} < 1$

If average detection probability is less than 1, the histogram will increase and then decline.



Point Transects. $\bar{p} < 1$

The fitted curve will look like this



Assignment

Read Chapter 10 – Capture-Mark-Recapture