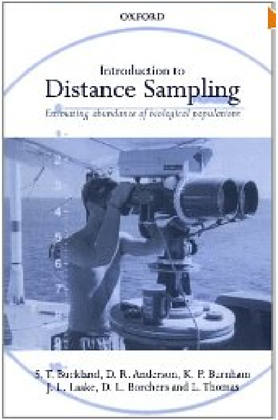
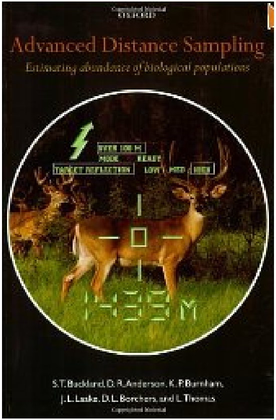
Distance sampling





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

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Most methods differ in how they estimate p

Challenges

- Detection probability is rarely constant

Challenges

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

Basic idea

- p_i is the probability of detecting individual i at distance x_i.

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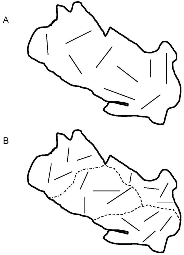
Advantages of distance sampling

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

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

Line transects

Figure 9.5



Point transects

Figure 9.7

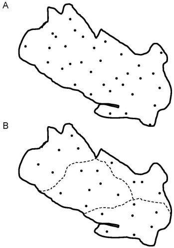
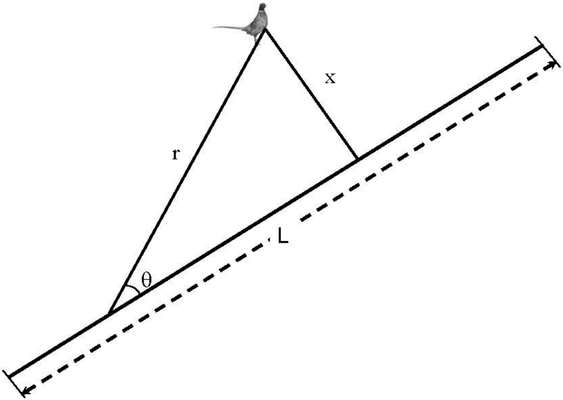
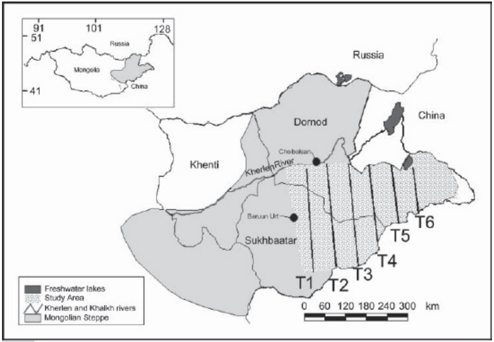


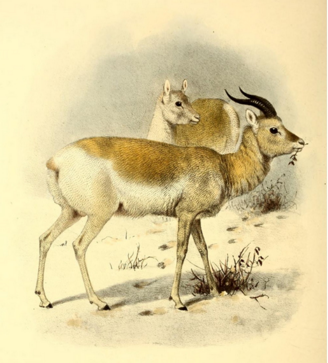
Figure 9.1



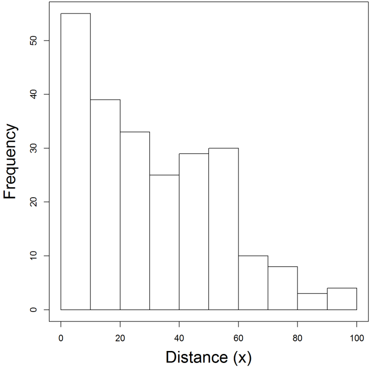
In line transect sampling, it is common to record the radial distance and bearing, rather than the perpendicular distance. However, the analysis must be conducted on the perpendicular distance data.

Mongolian gazelle
Procapra gutturosa

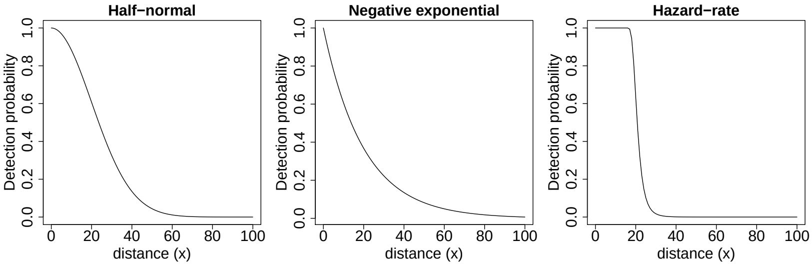




Data	
Animal	Distance (x)
1	4.4
2	25.3
3	41.8
4	3.1
5	78.5
$\vdots$	
n	4.4

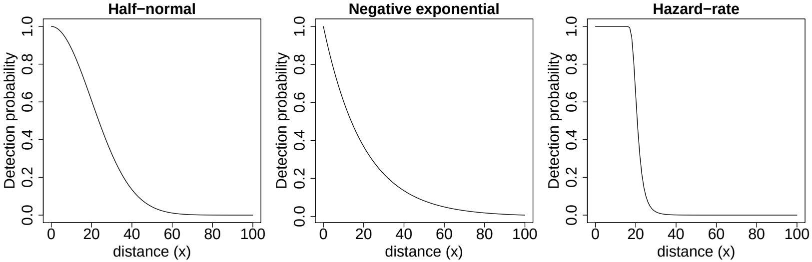


- Fit a detection function, $g(x)$, to the data
  - Assume $g(0) = 1$



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

- Fit a detection function, $\mathrm{g}(x)$, to the data
  - Assume $\mathrm{g}(0) = 1$
- Assume individuals are "uniformly" distributed with respect to the transect (valid under random sampling): $p(x) = 1/B$ where B is the transect half-width.



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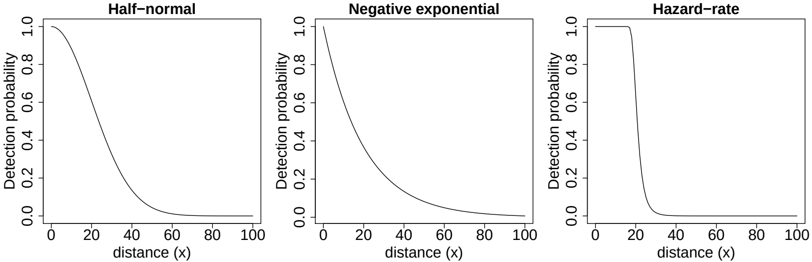
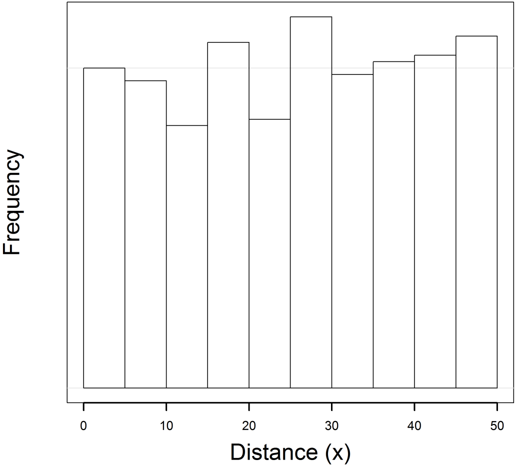
- Assume individuals are "uniformly" distributed with respect to the transect (valid under random sampling): $p(x) = 1/B$ where B is the transect half-width.
- $\bar{p}$ is then the average detection function, weighted by $p(x)$.

$$\bar{p} = \int_0^B g(x)p(x)\mathrm{d}x$$

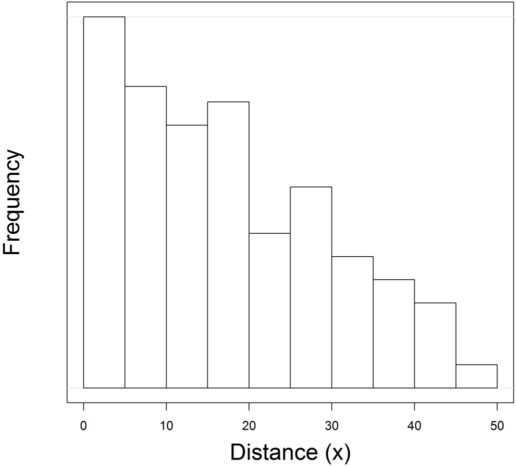
.



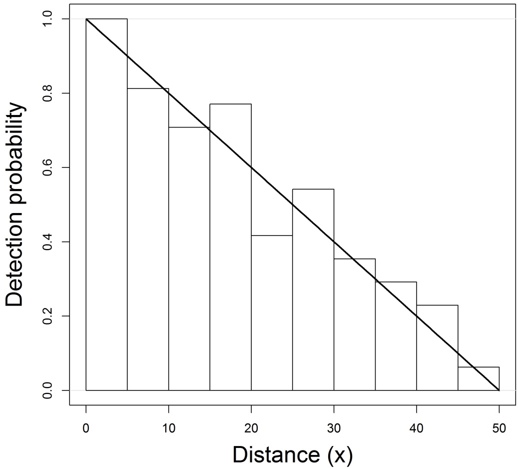
Computing $\bar{p}$, average detection probability



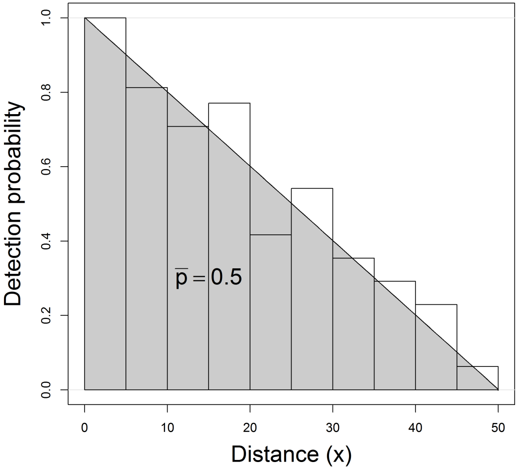
Computing $\bar{p}$, average detection probability

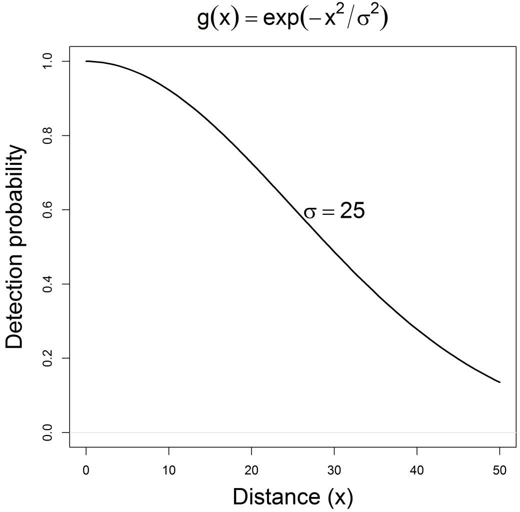


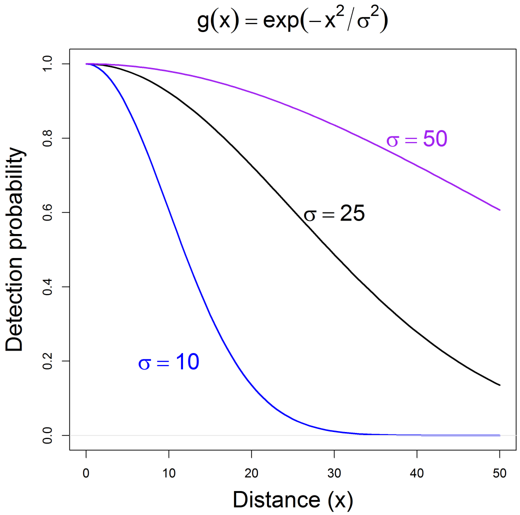
Computing $\bar{p}$, average detection probability



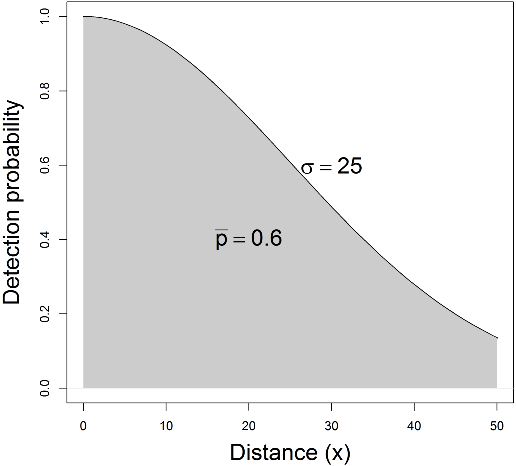
Computing $\bar{p}$, average detection probability



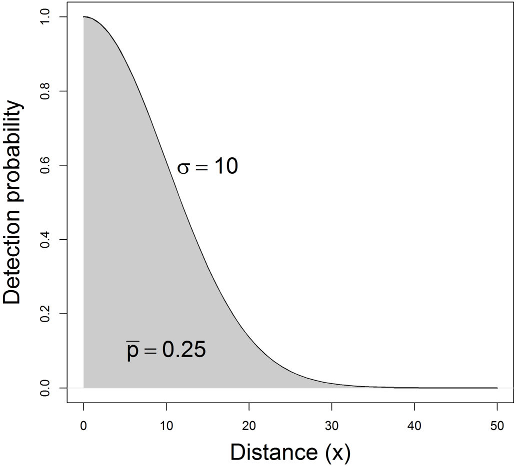

$g(x) = \exp(-x^2/\sigma^2)$
Detection probability
Distance (x)
$\sigma = 25$
0.0
0.2
0.4
0.6
0.8
1.0
0
10
20
30
40
50


g(x) = exp(−x^2/σ^2)
1.0
0.8
0.6
0.4
0.2
0.0
Detection probability
σ = 50
σ = 25
σ = 10
0
10
20
30
40
50
Distance (x)

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



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



https://richard-chandler.shinyapps.io/distance-sampling/

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

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

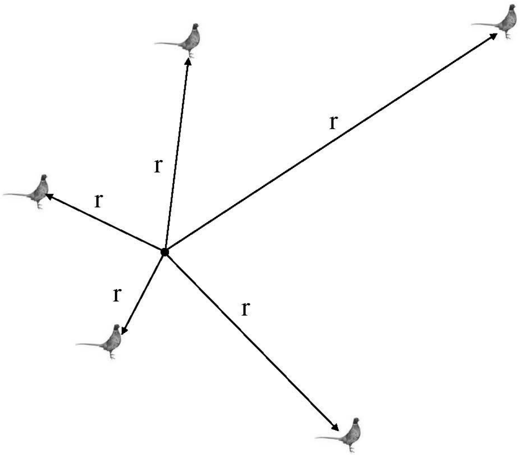
(4) Transect lines are placed randomly with respect to the animals

- 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



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

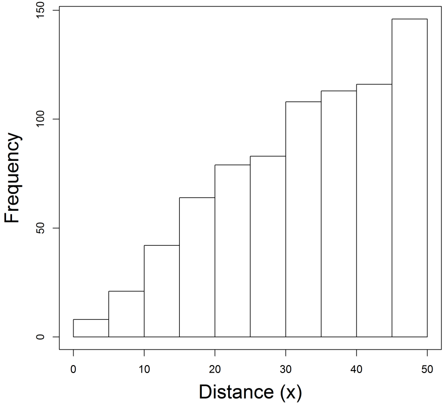
Differences between point vs line transects

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

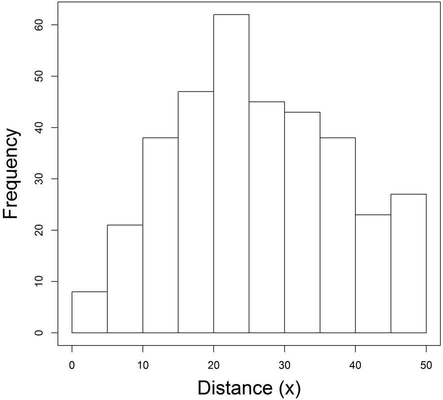
We don't expect a "flat" histogram of distances when $\bar{p} = 1$. Why?

More individuals occur far from the observer than close to the observer because area increases with distance.

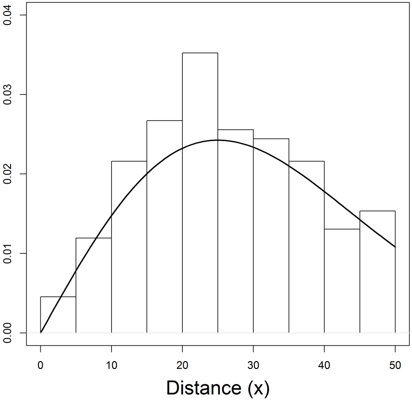
When average detection probability is 1, the histogram of distances will look like this because there is more area (and hence more individuals) far from the point.



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



The fitted curve will look like this



Read Chapter 10 – Capture-Mark-Recapture