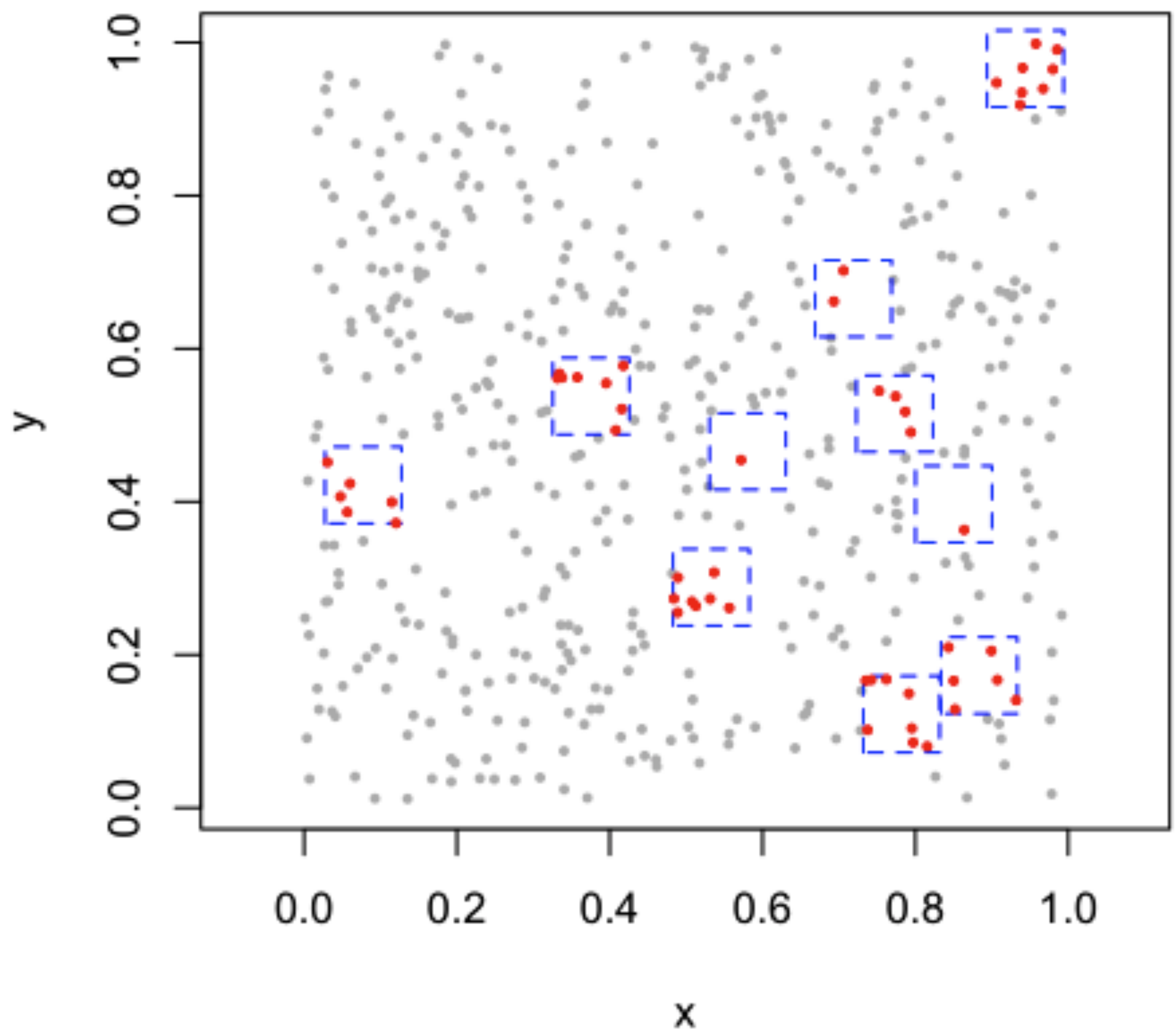
Week 9: Distance Sampling

WLF 504: Applied Population Analysis
Fall 2017

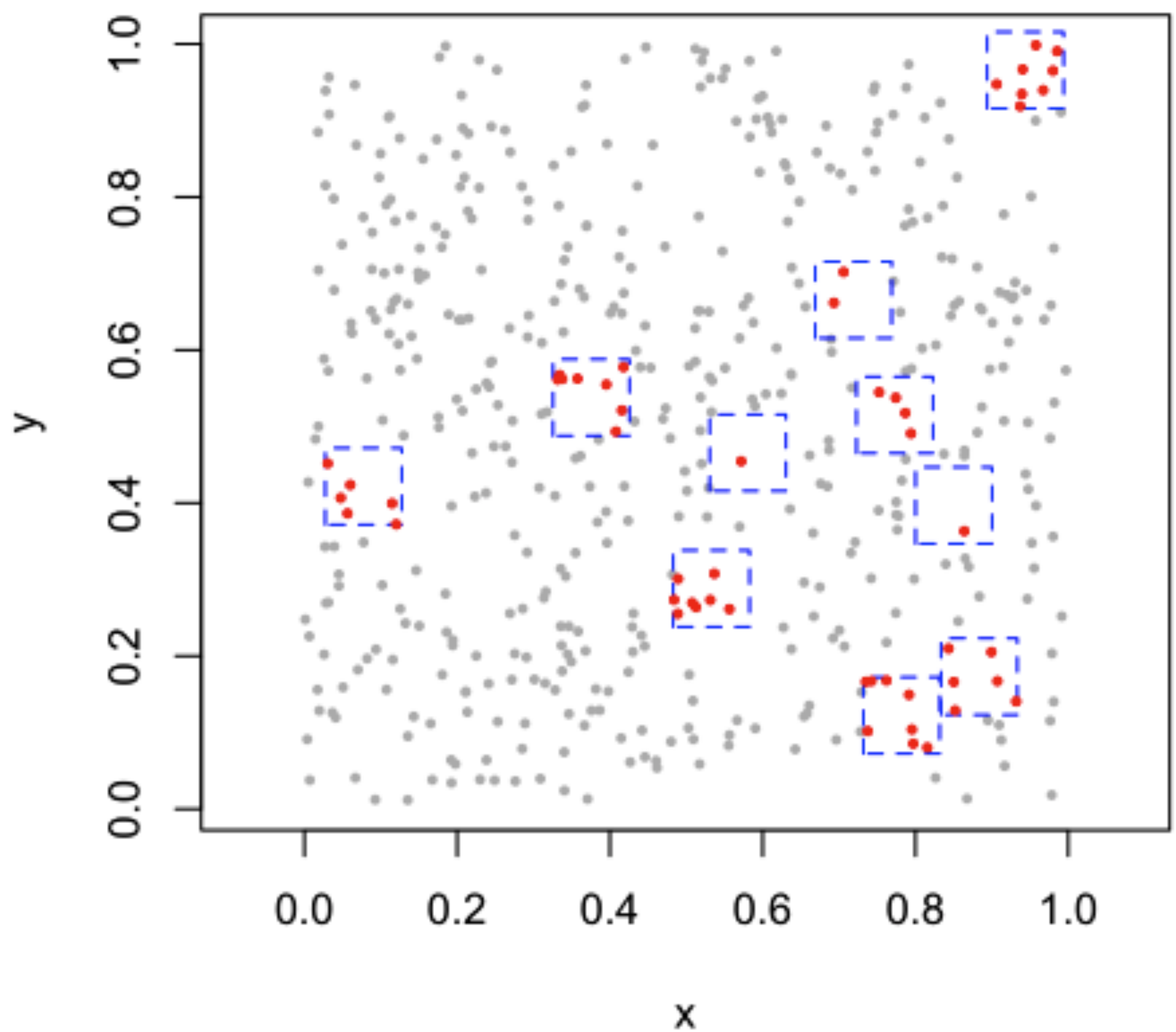
Why distance sampling?

Could count animals in random quadrats…



Why distance sampling?

Density/abundance easy to estimate…

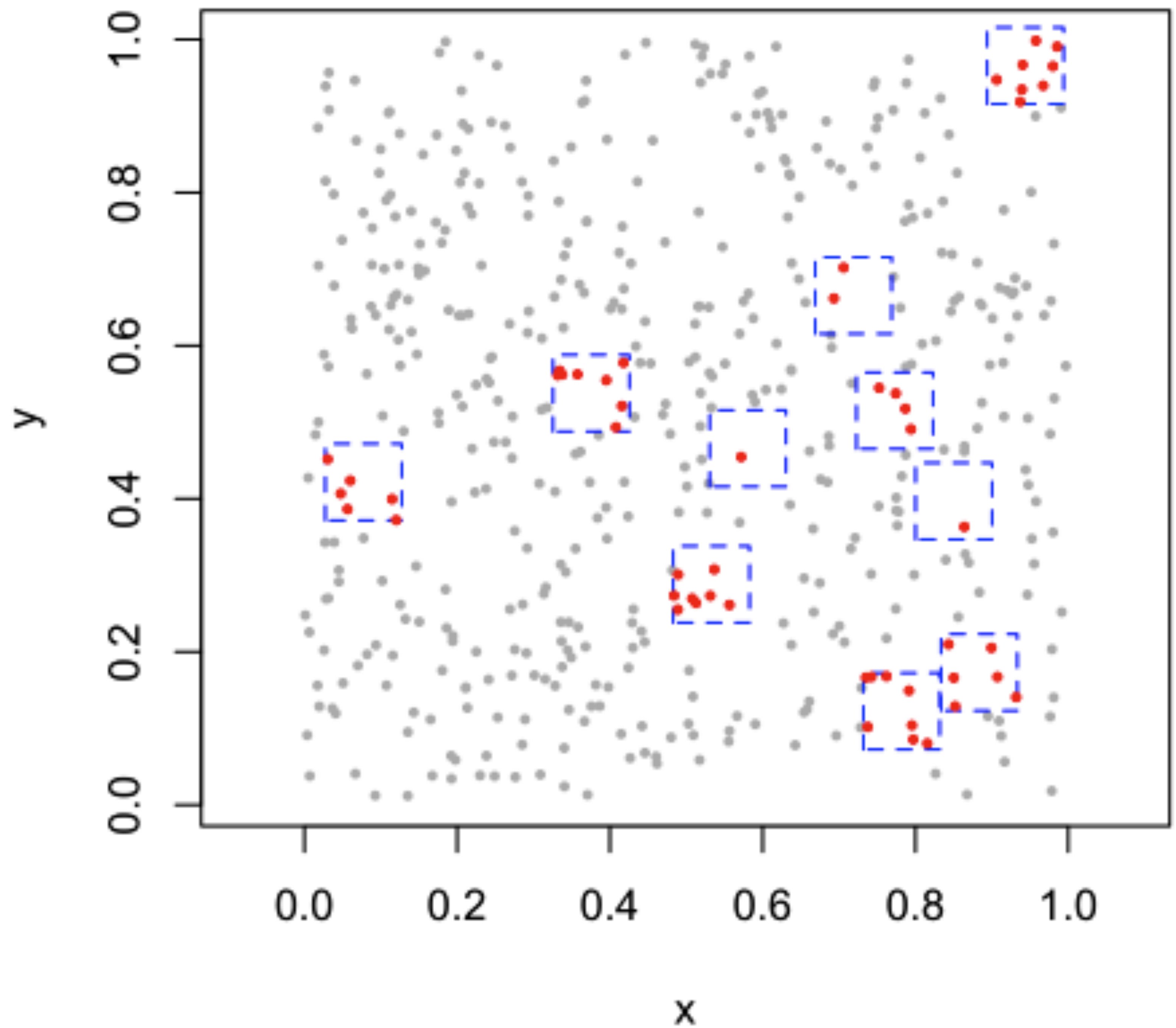


D = N/A

Density= Number of animals/area

Why distance sampling?

Density/abundance easy to estimate if we count ALL critters in the quadrats…

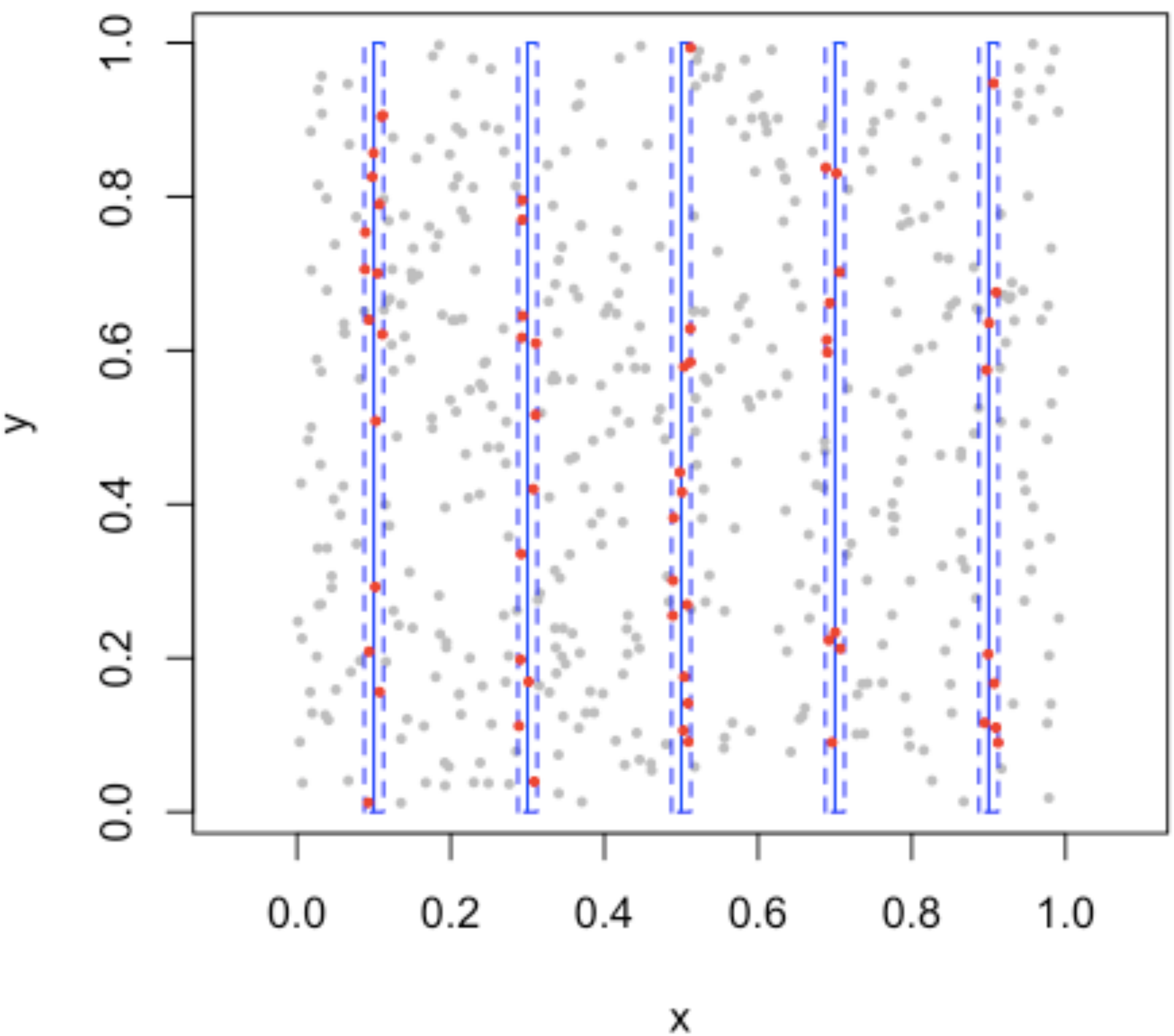


$$\hat{D} = n/a$$

Density est. = number counted/ covered area

But much more convenient to walk transects…

Density/abundance calc. the same if we see ALL critters within the transect strip…

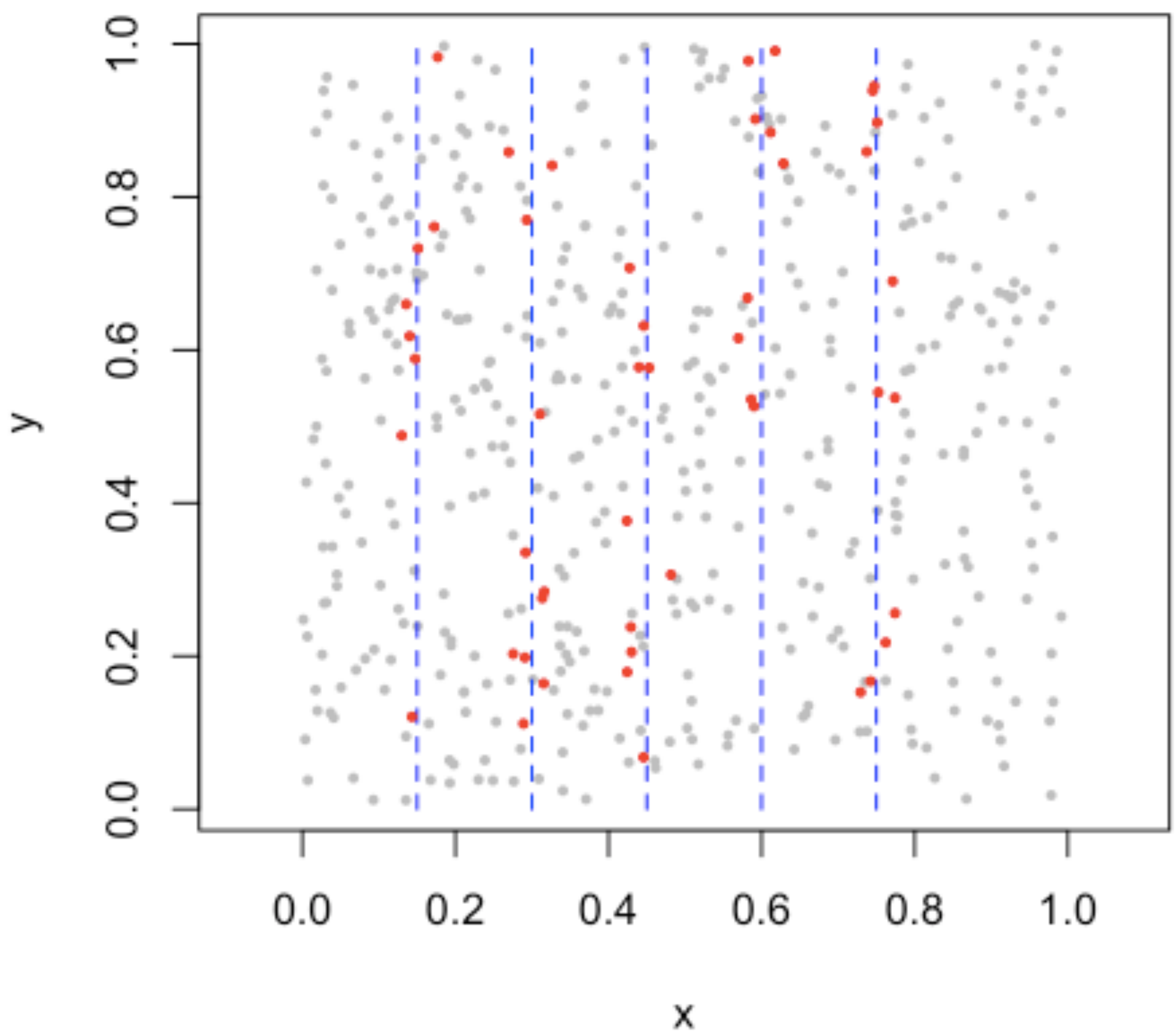


$$\hat{D} = n/a$$

Density est. = number counted/ covered area

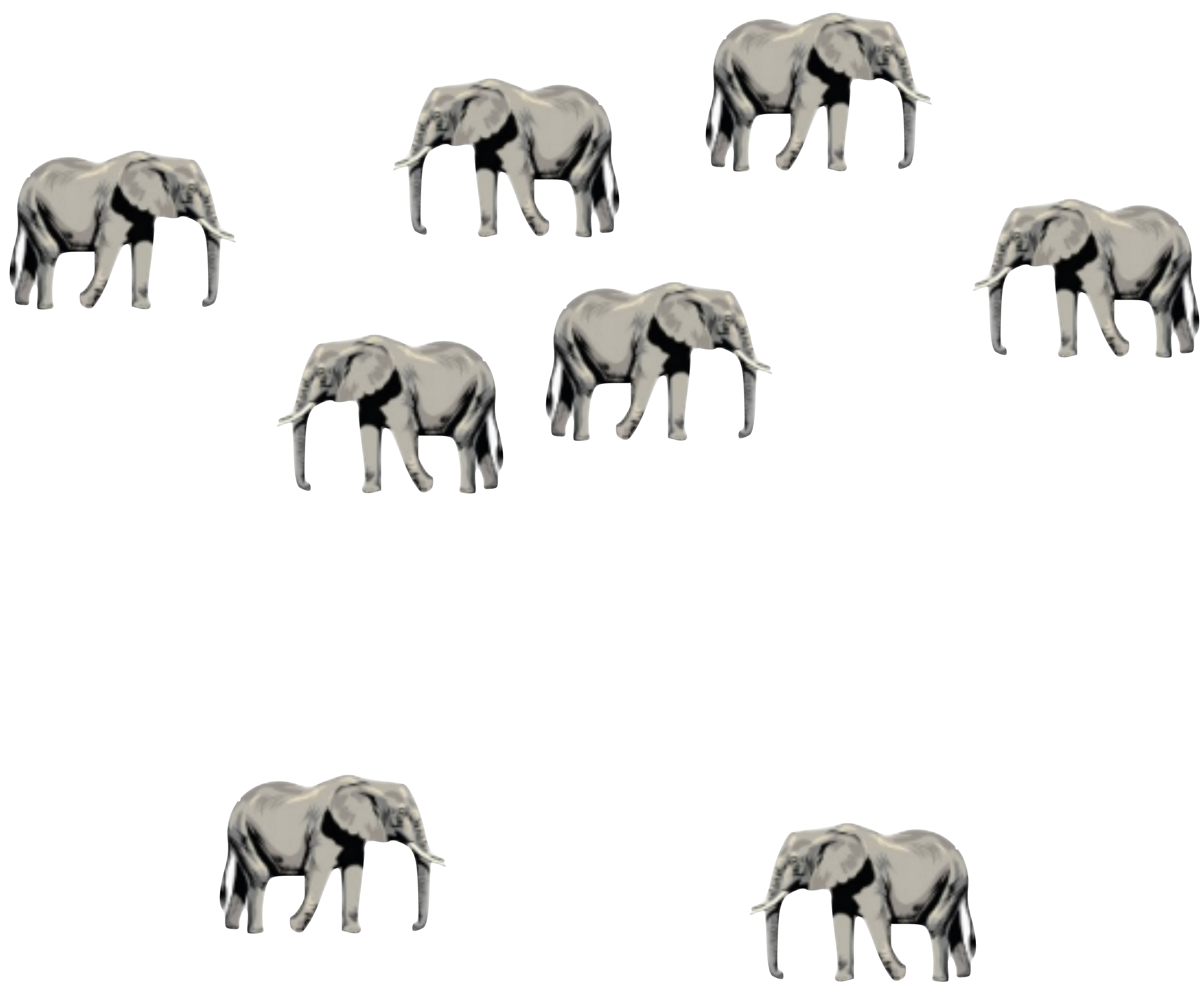
But…

We definitely don't see all the animals along a transect within a certain strip



—> imperfect detection (P), dependend on **distance** from transect

What is distance sampling?



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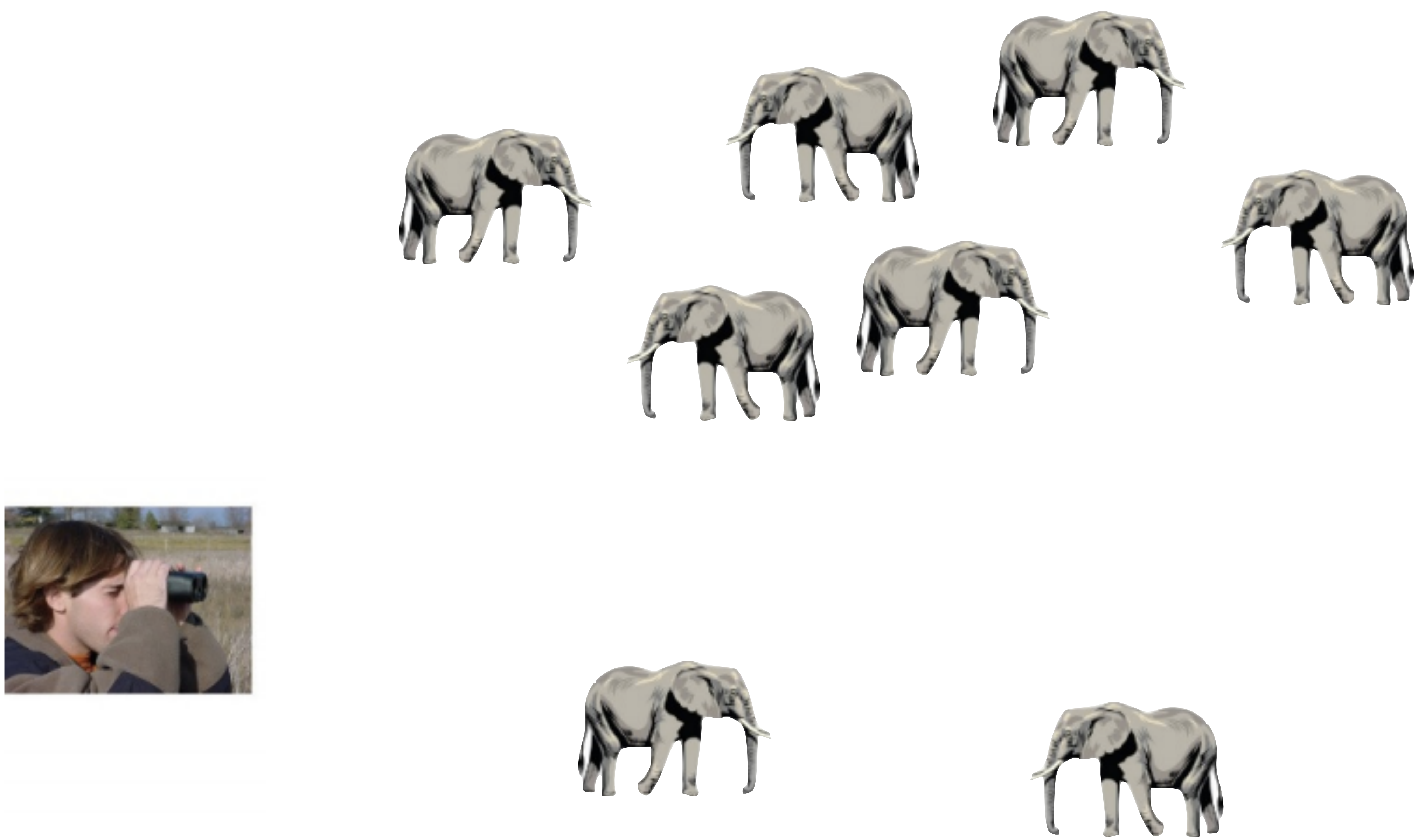
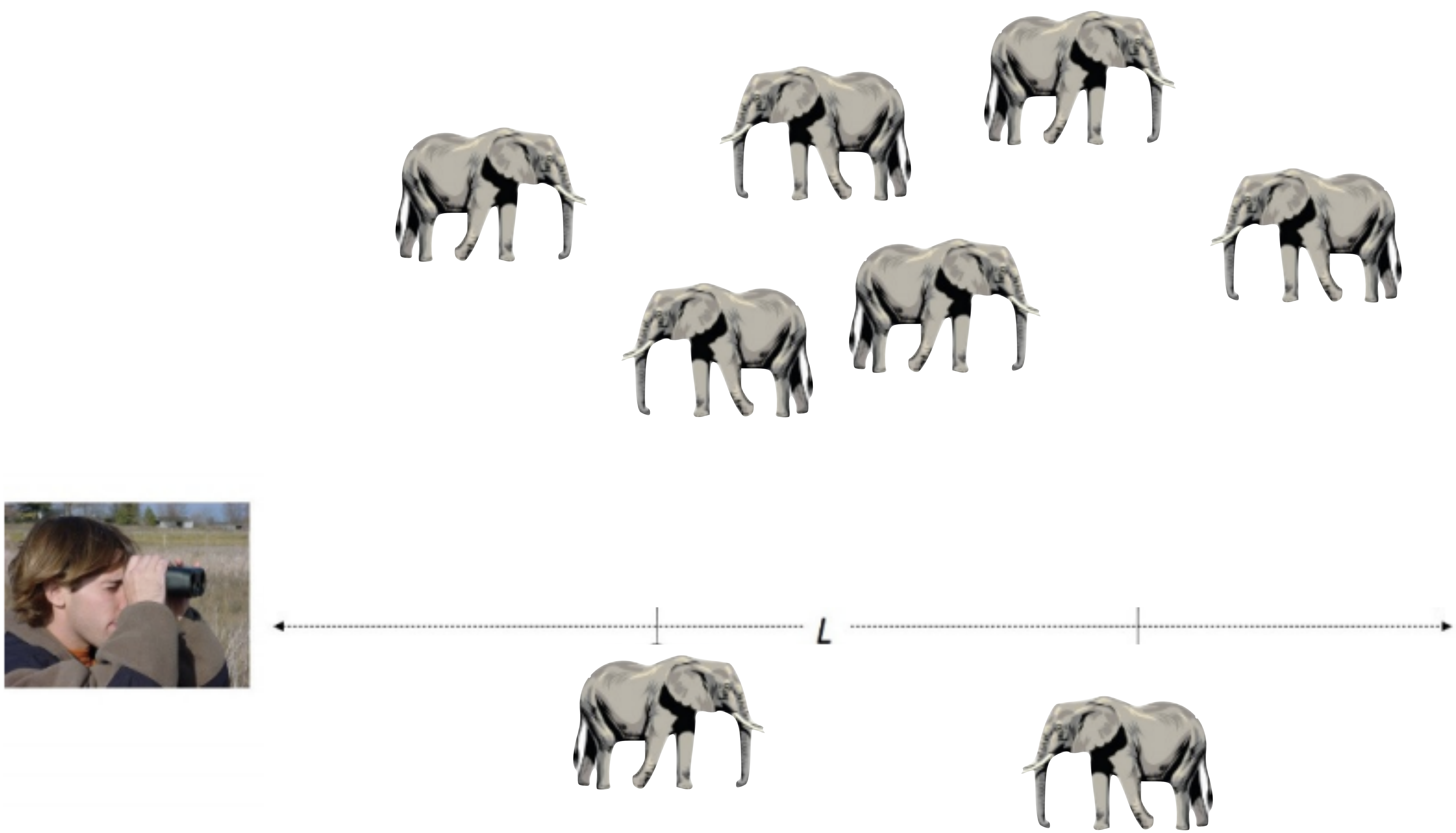
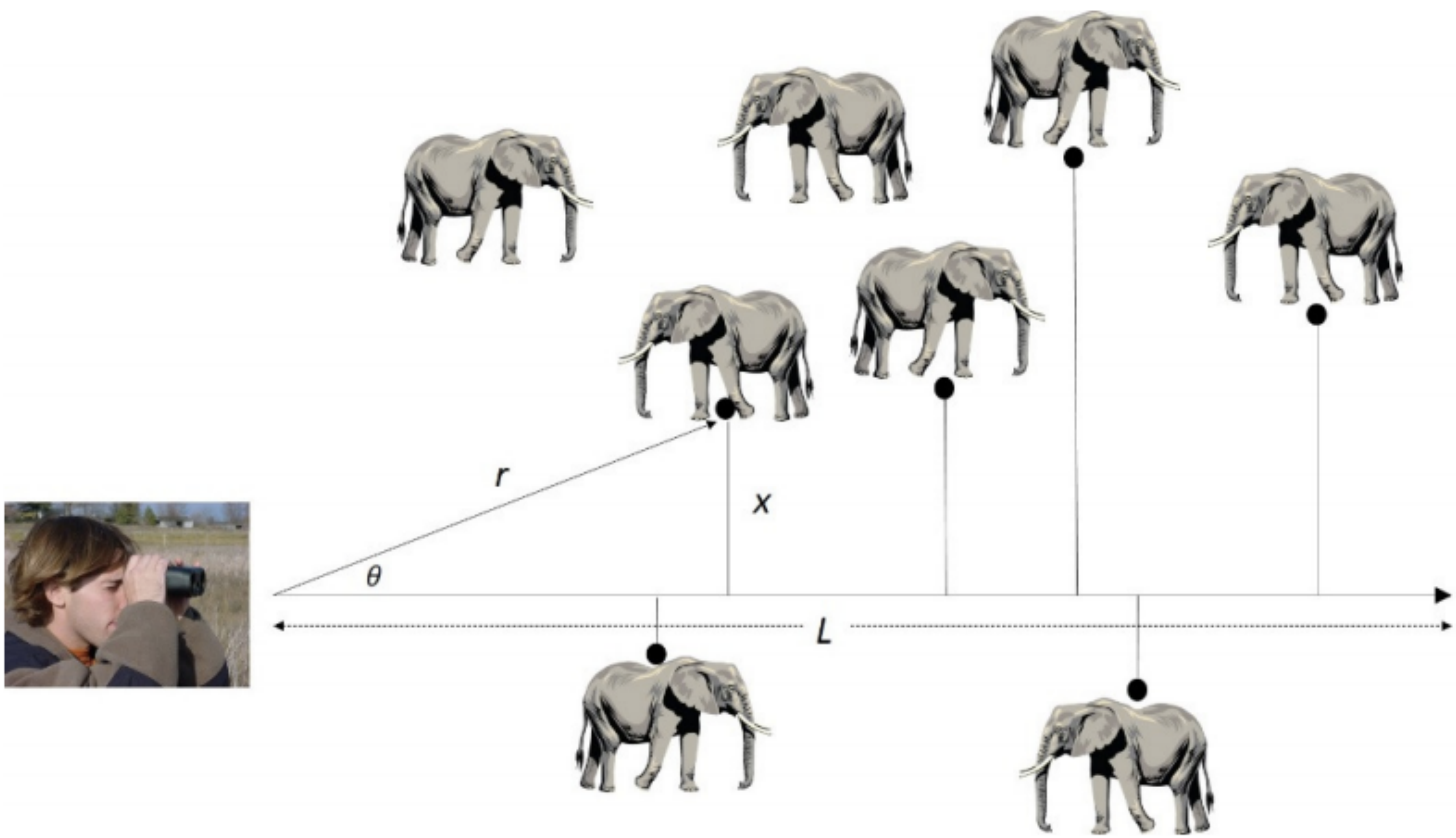


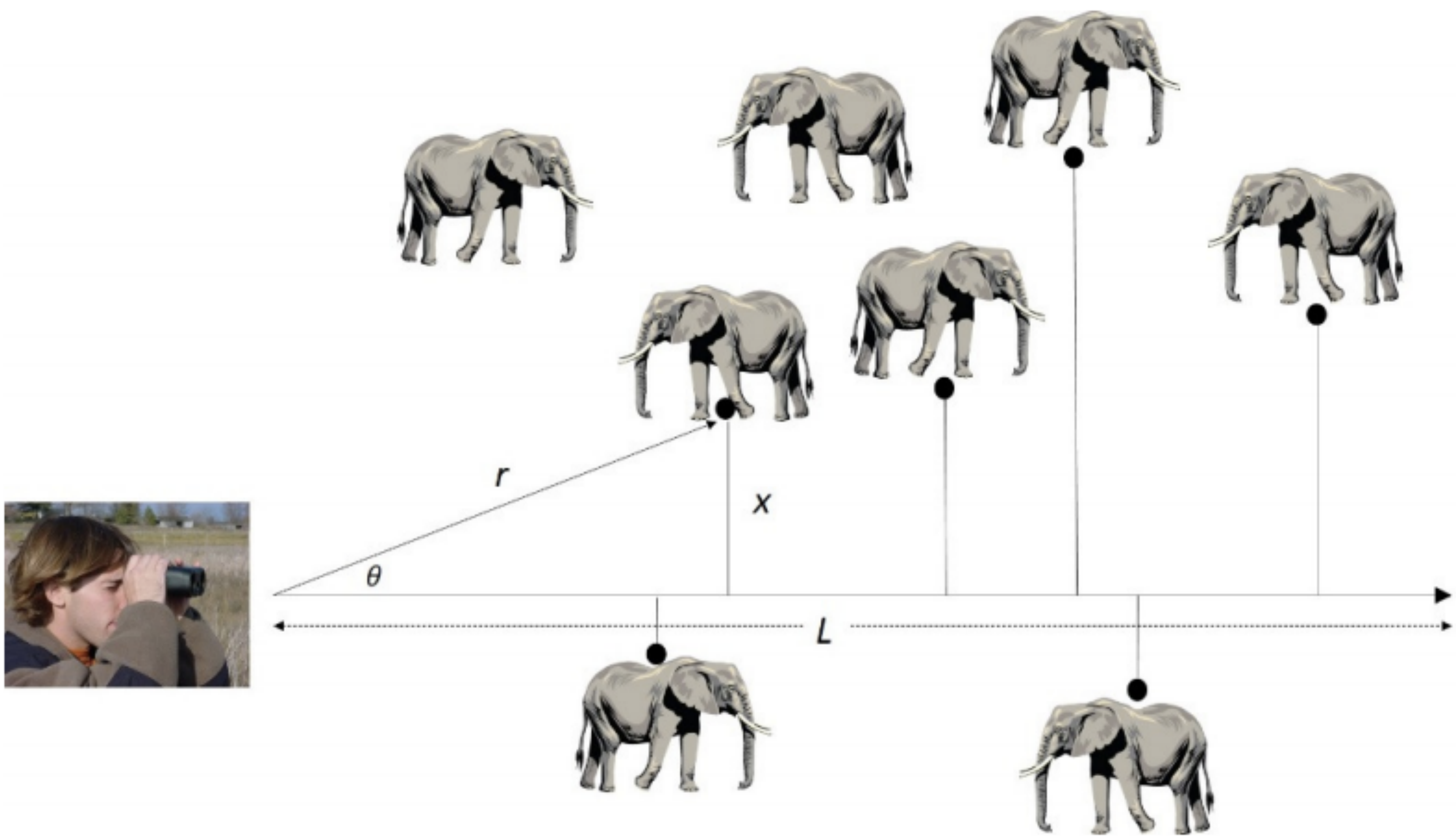
What is distance sampling?



Animal doesn't need to be perpendicular to observer…

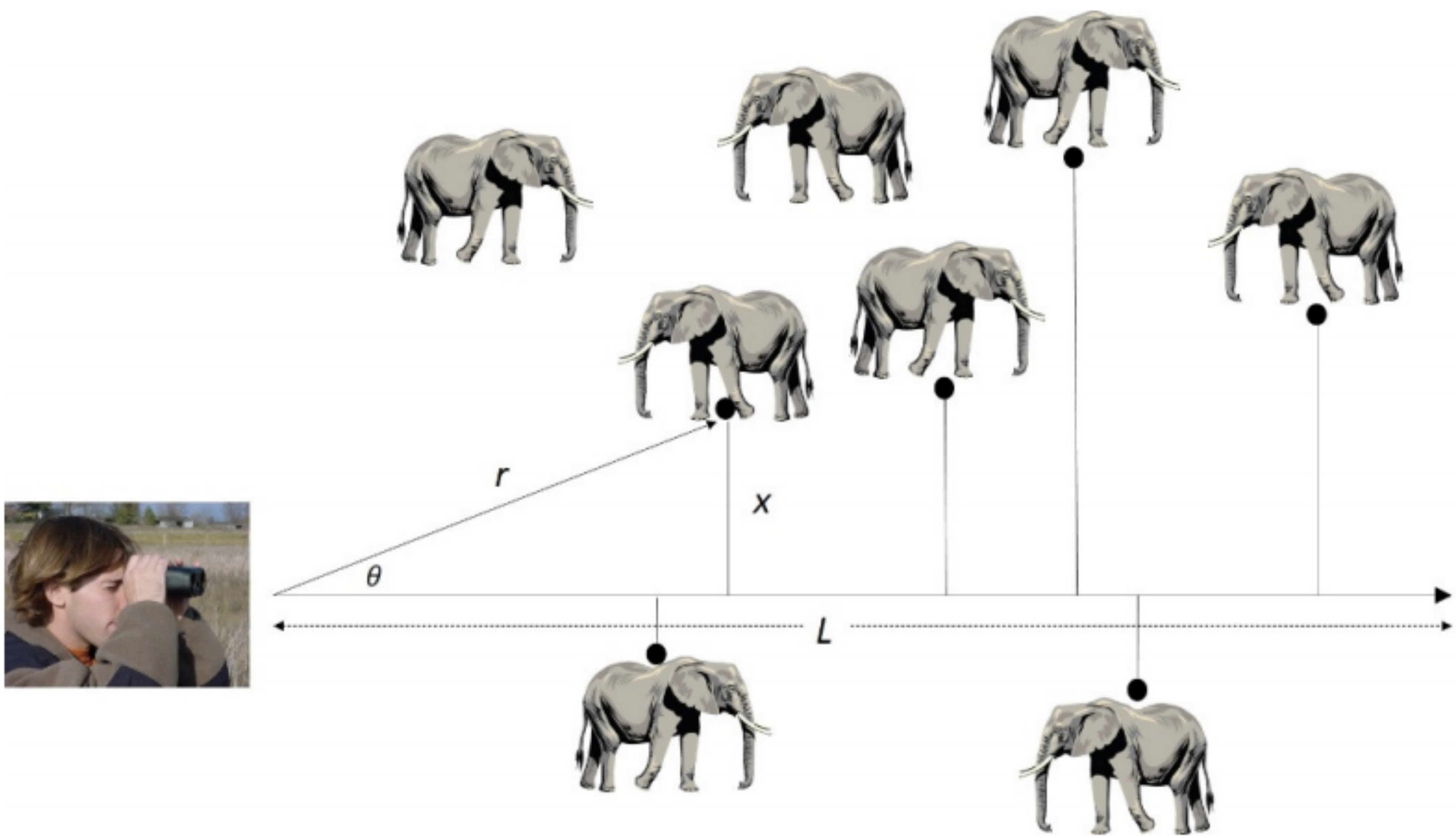


Want to solve for x…

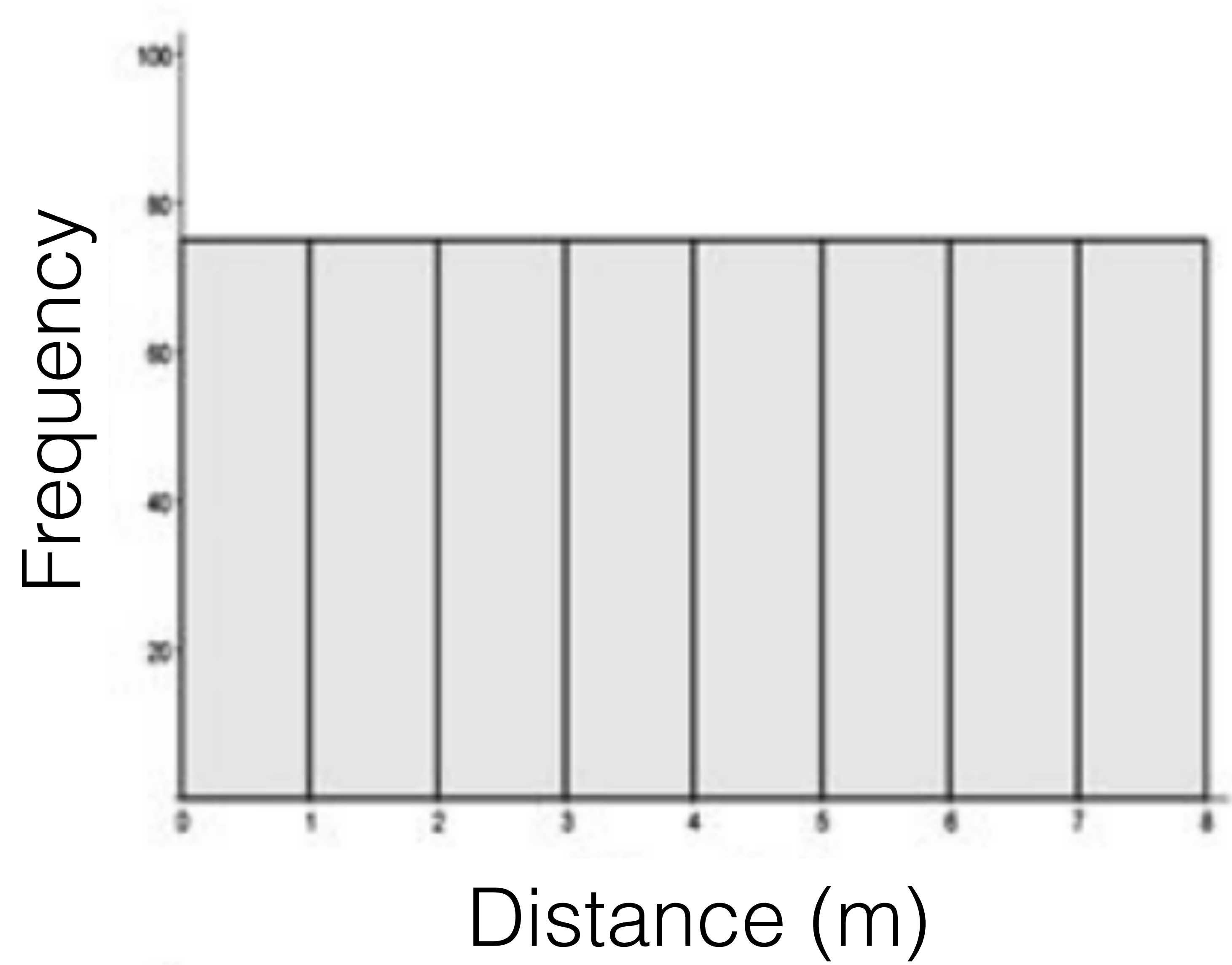


$$\text{Sin}(\theta) = r/x$$

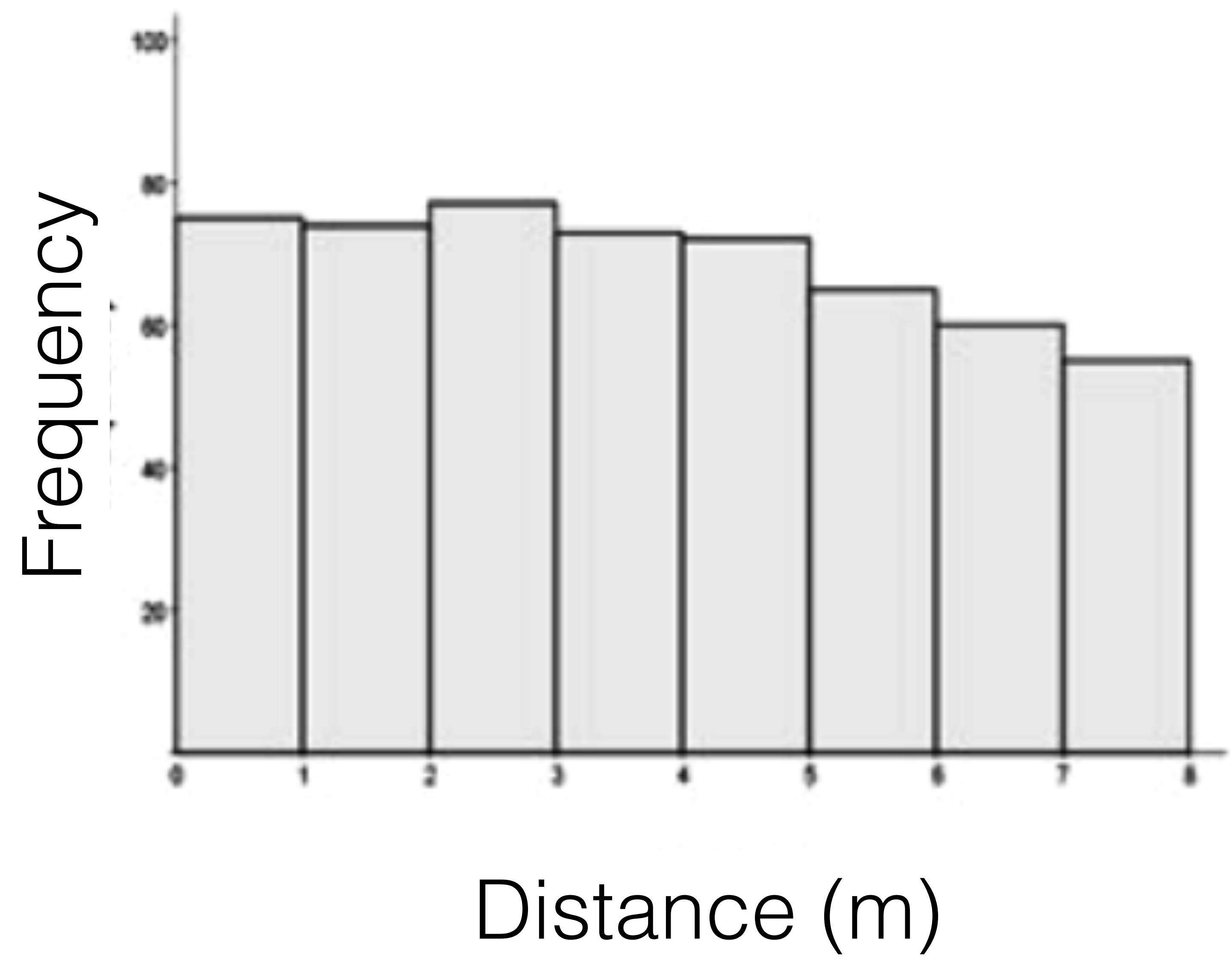
$$\mathbf{x = Sin(\theta)/r}$$



If we had perfect eyesight out to infinity…

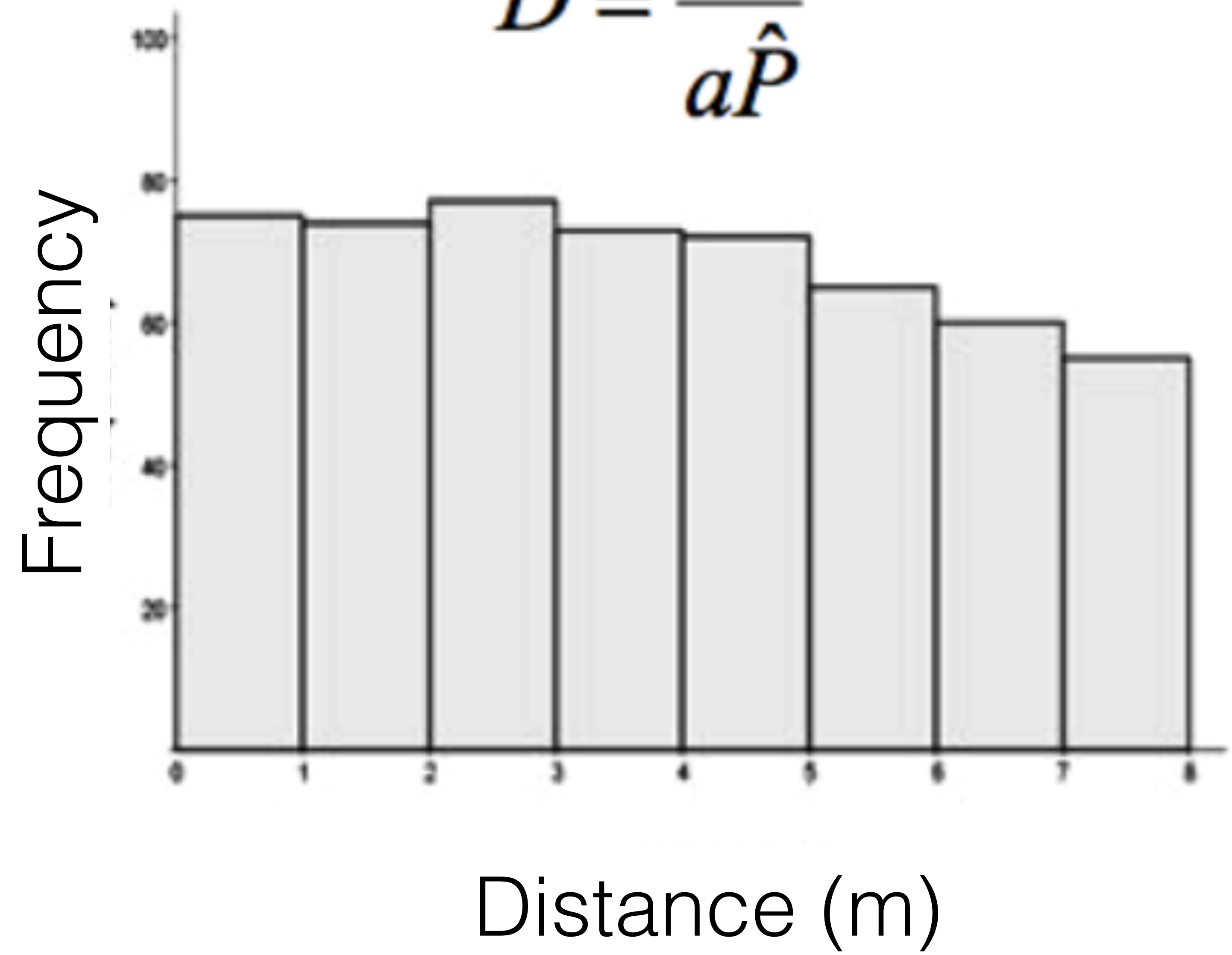


But we don’t… detection declines with distance



Which means we are missing some critters from our sampled area that were farther away

$$\hat{D} = \frac{n}{a\hat{P}}$$



Which means we are missing some critters from our sampled area that were farther away

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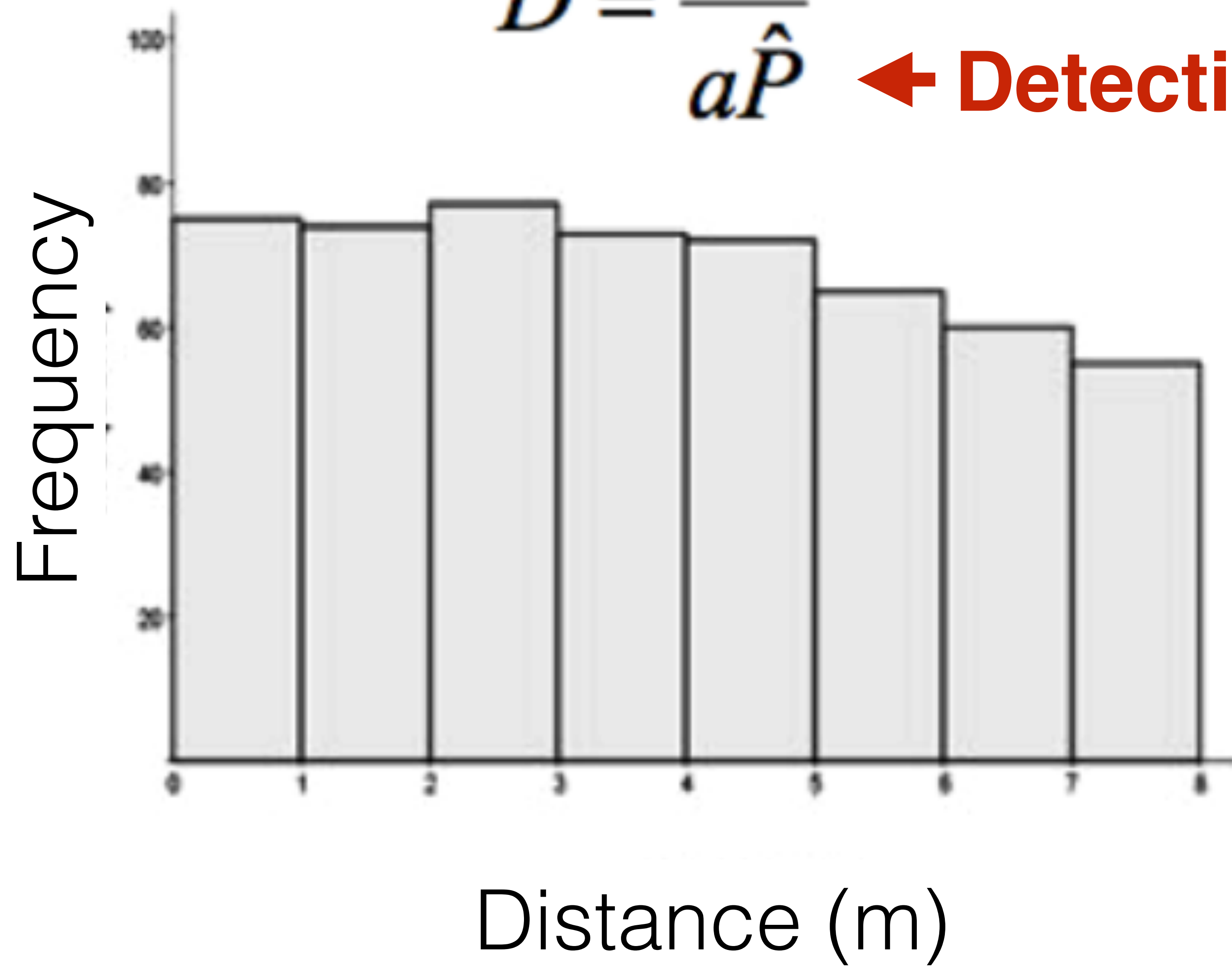
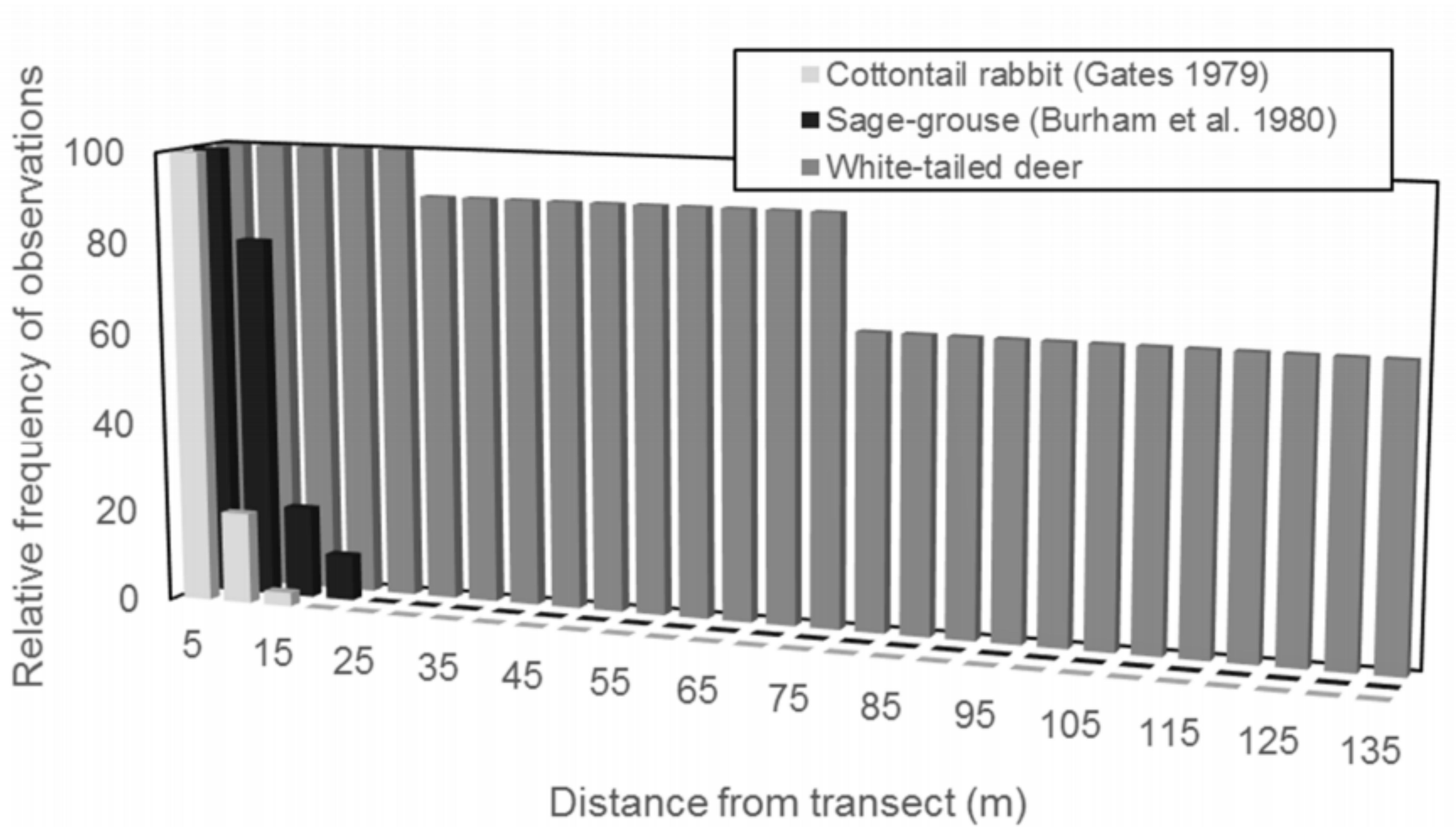
Detection probability



Detection ~ distance relationship varies by species

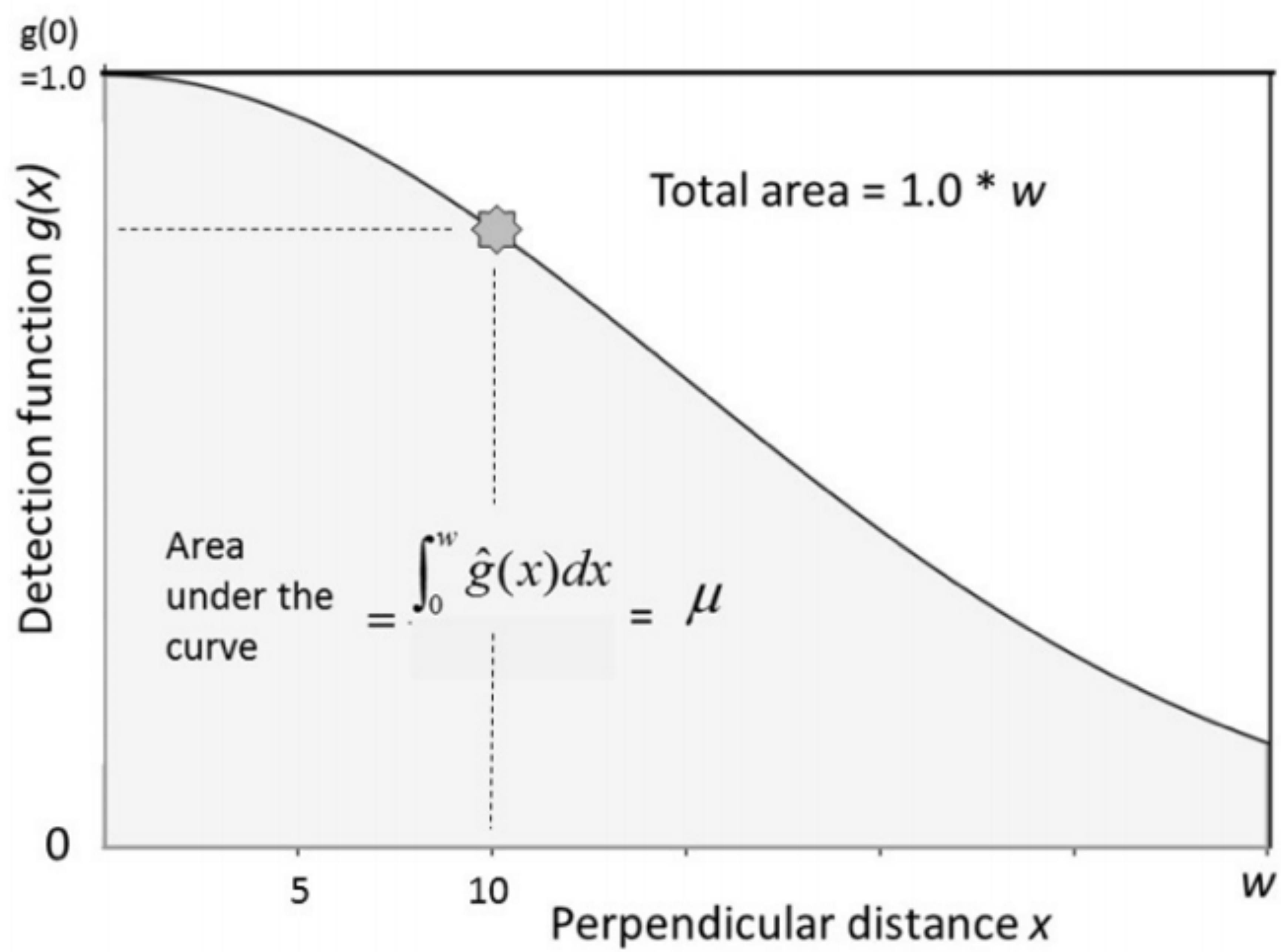


Key assumptions of distance sampling:

- Transect lines (or points) are randomly placed
- Objects directly on/at the line/point are detected with certainty (P = 1.0)
- Objects are detected at their initial location
- Measurements or groupings of data are correct
- Sightings of individuals are independent events

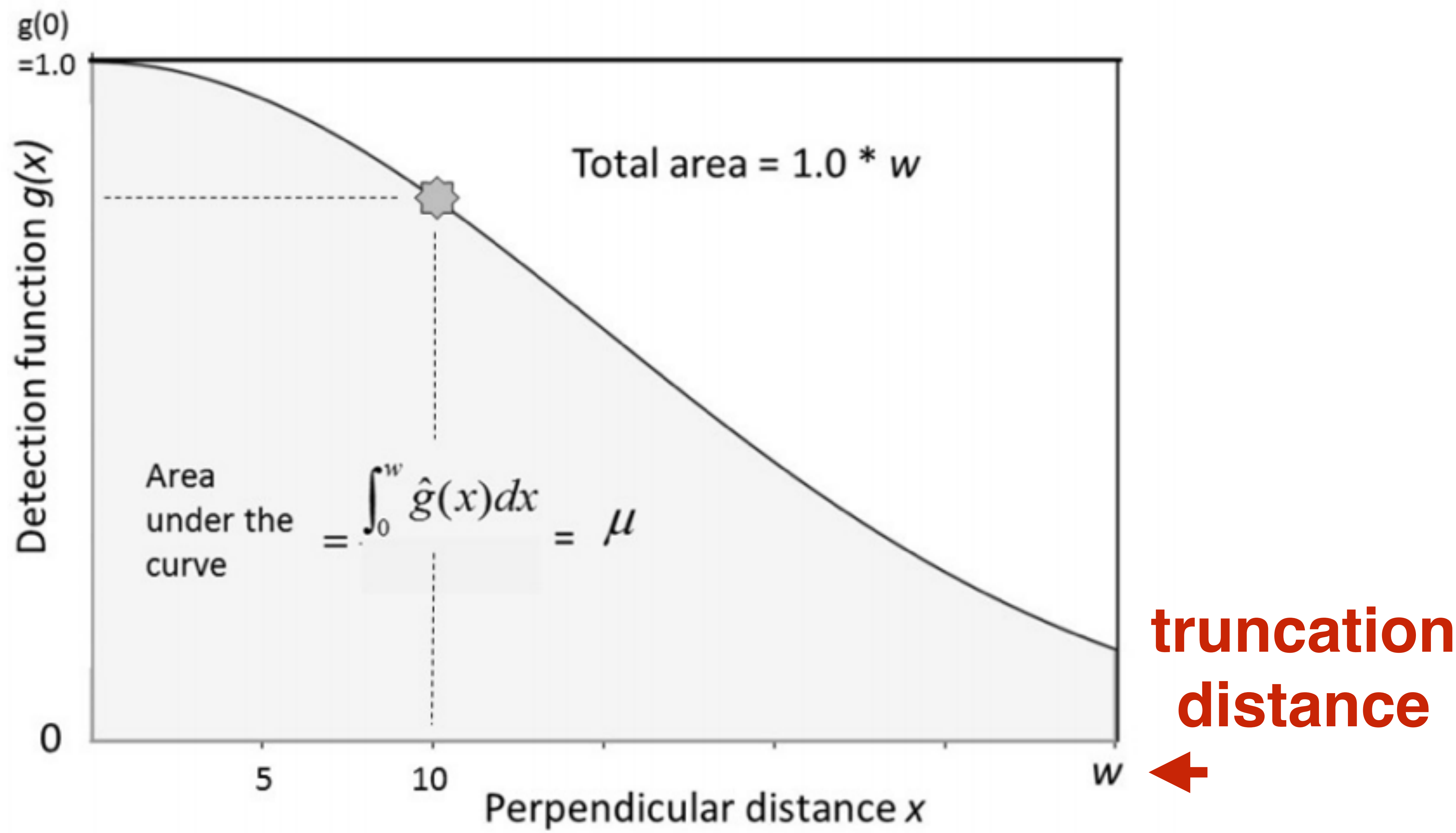
A smooth detector function:

P = area under curve/total area

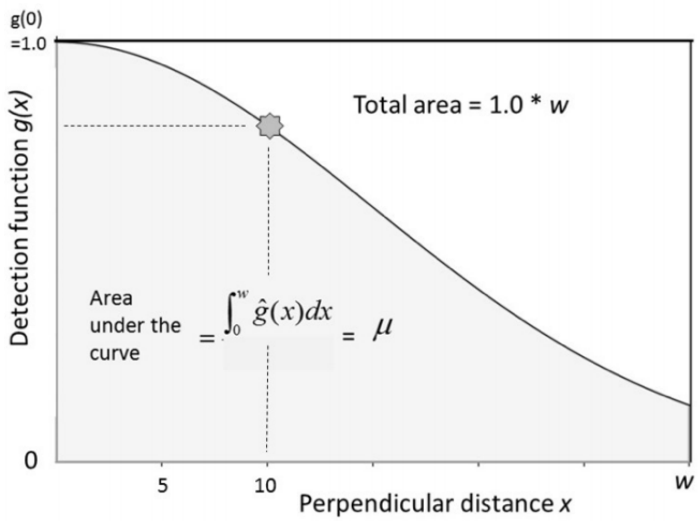


A smooth detector function:

But we cannot observe
probabilities of detection, g(x), directly!
What to do?



A smooth detector function:

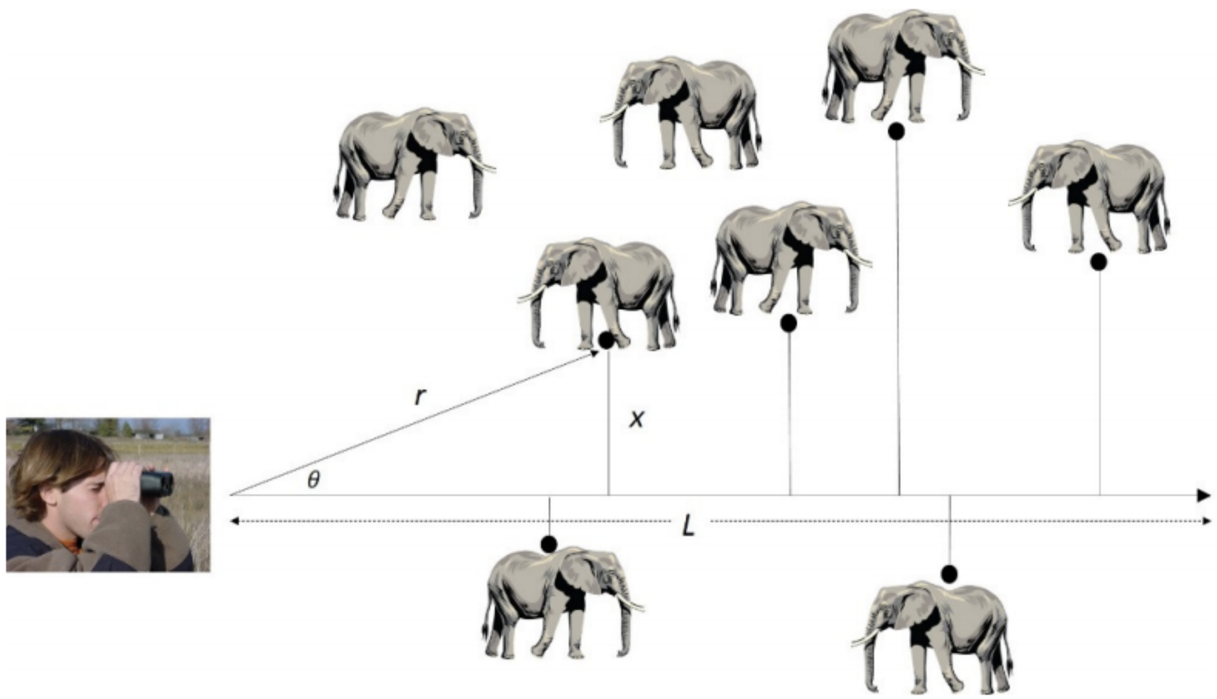


f(x) we can quantify:
the frequency of animals observed at different distances from observer

 # seen at d>u =
 # NOT seen at d< u

f(x) is always scaled so max is 1

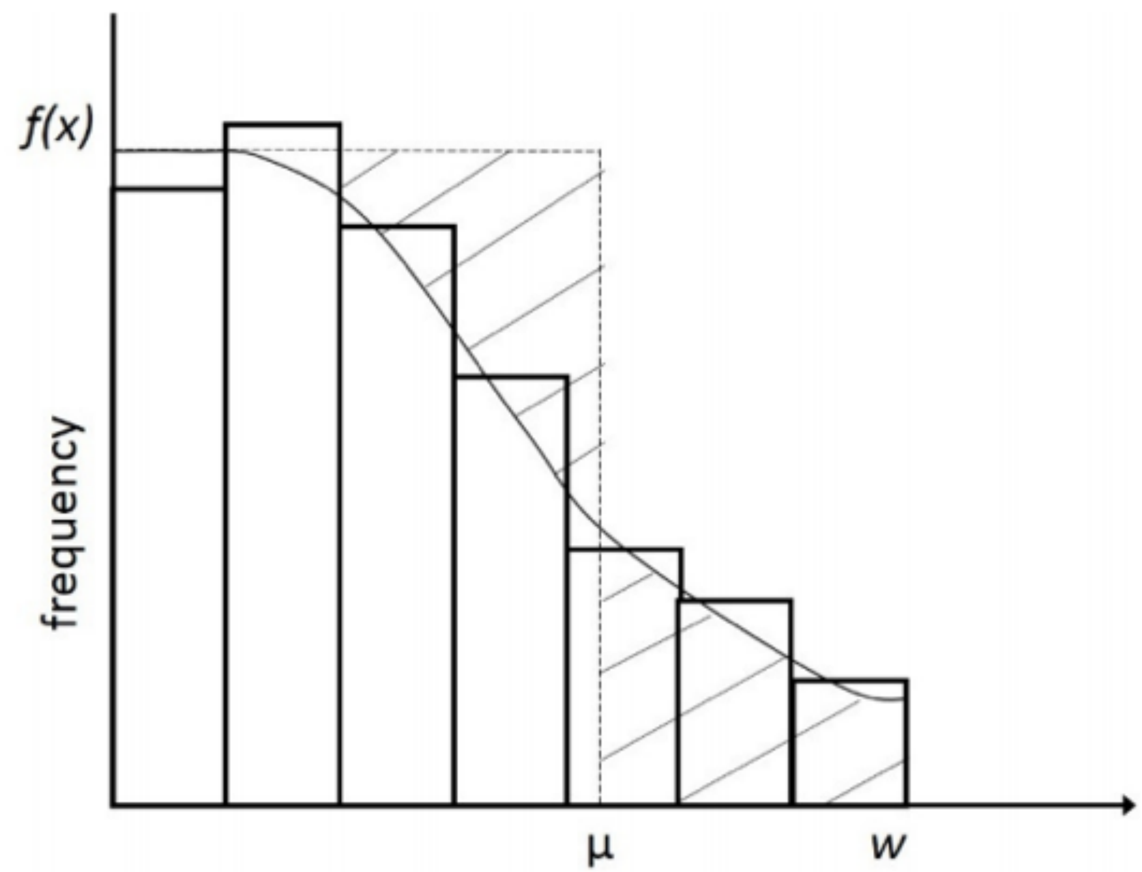
f(x) for line transect:



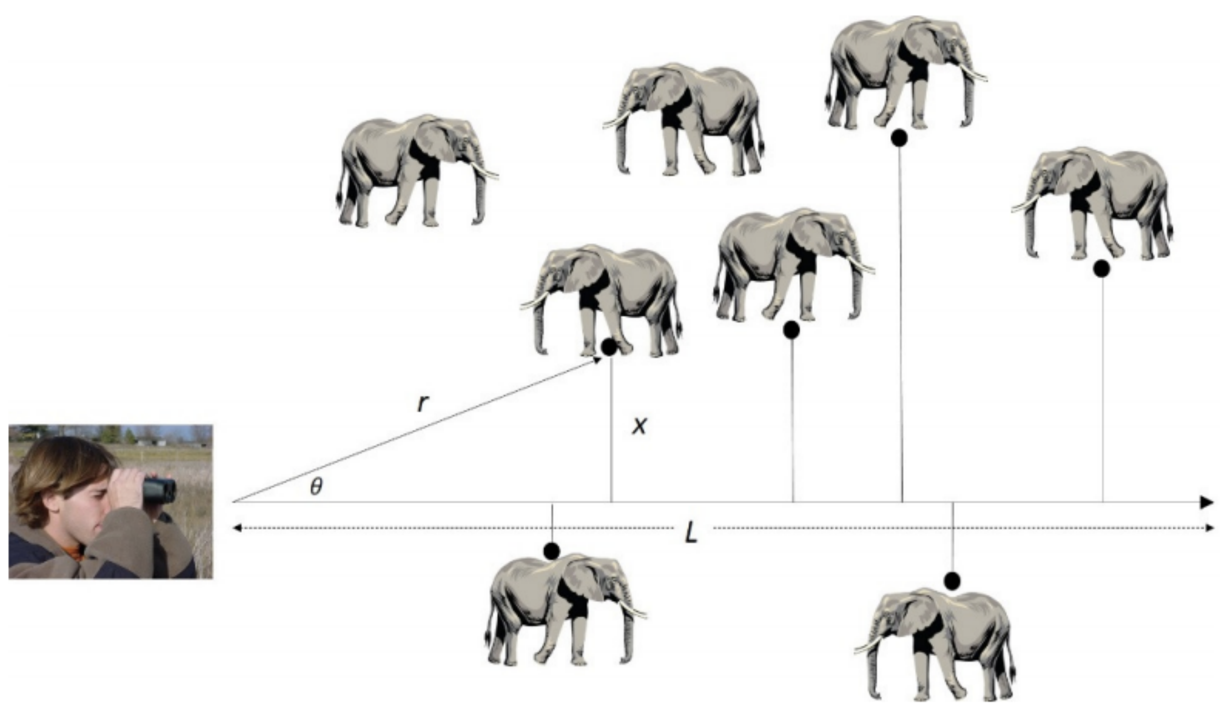
More animals detected closer to line than farther away

$$\hat{D} = \frac{n}{2w*L*K*\hat{P}}$$

truncation distance



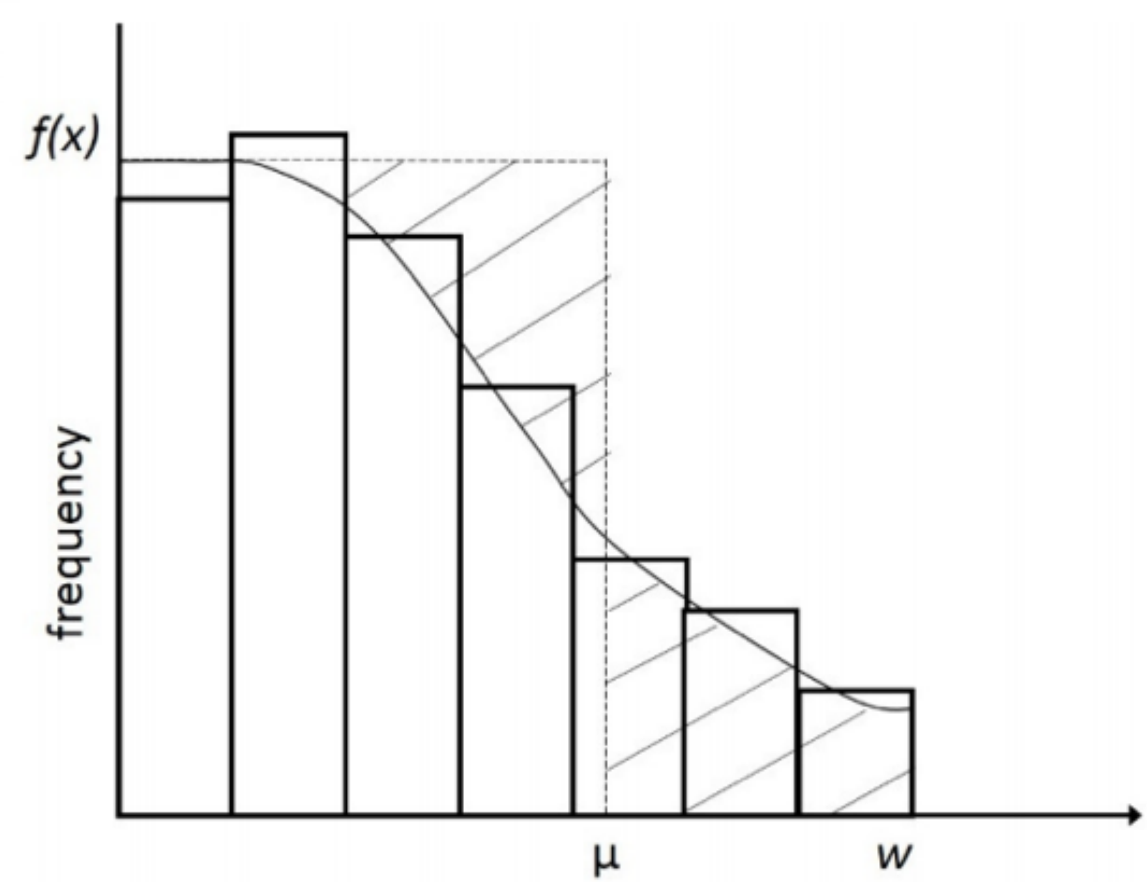
f(x) for line transect:



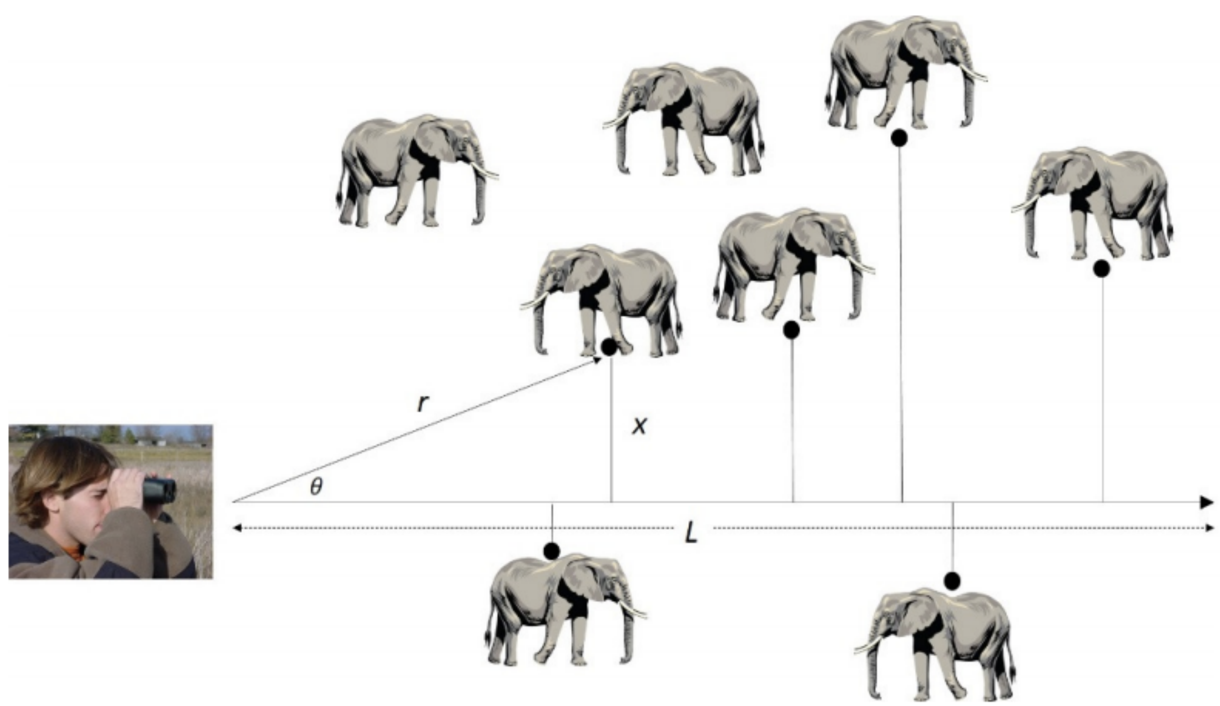
More animals detected closer to line than farther away

$$\hat{D} = \frac{n}{2w^*L^*K^*\hat{P}}$$

Length of transect



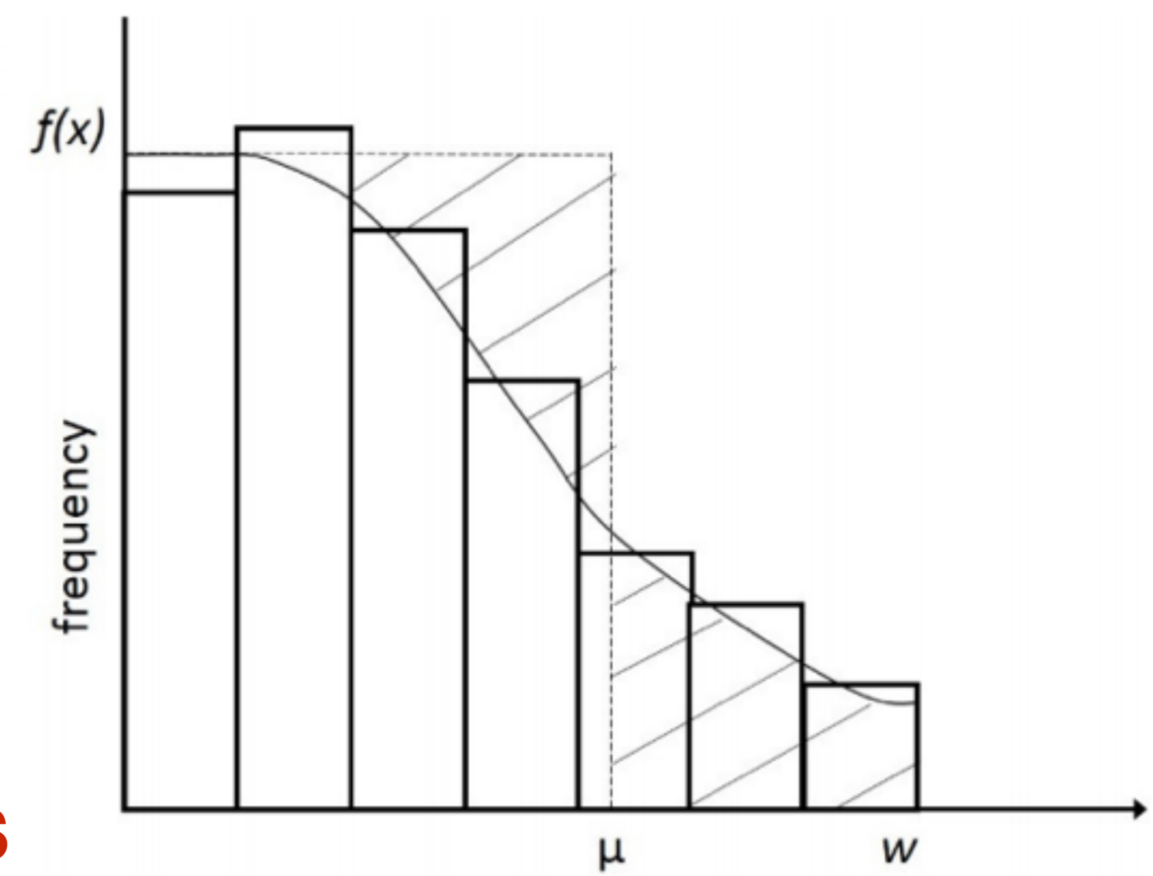
f(x) for line transect:



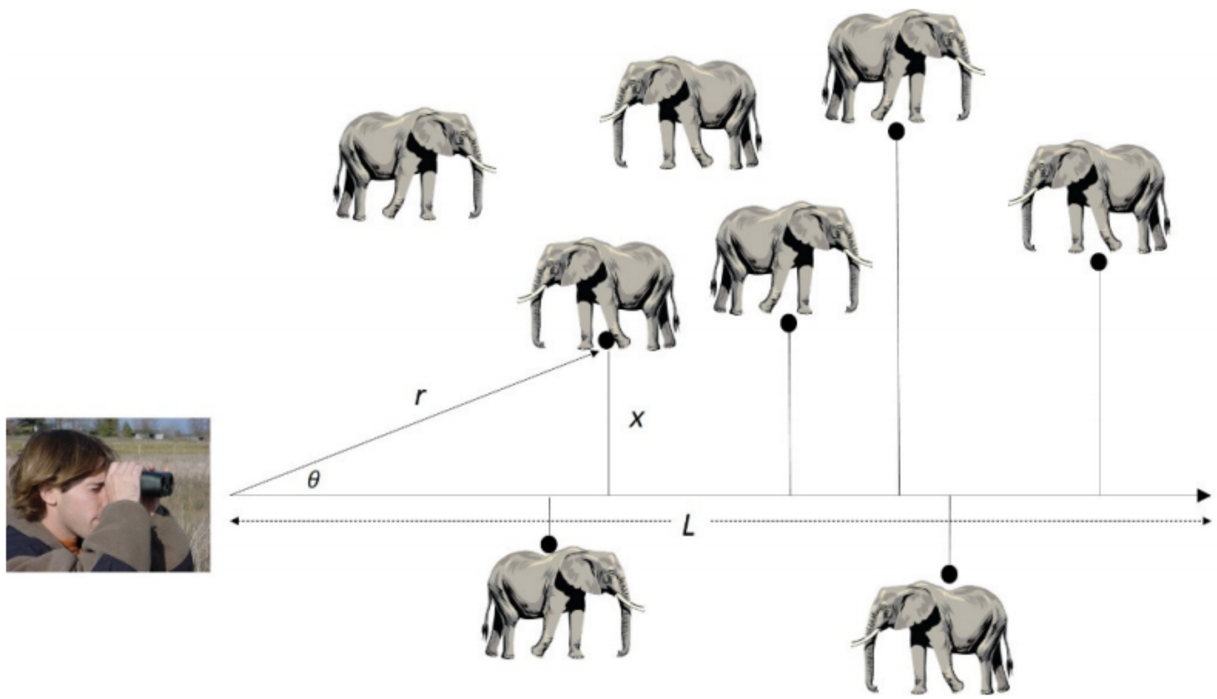
More animals detected closer to line than farther away

$$\hat{D} = \frac{n}{2w*L*K*\hat{P}}$$

Total number of transects



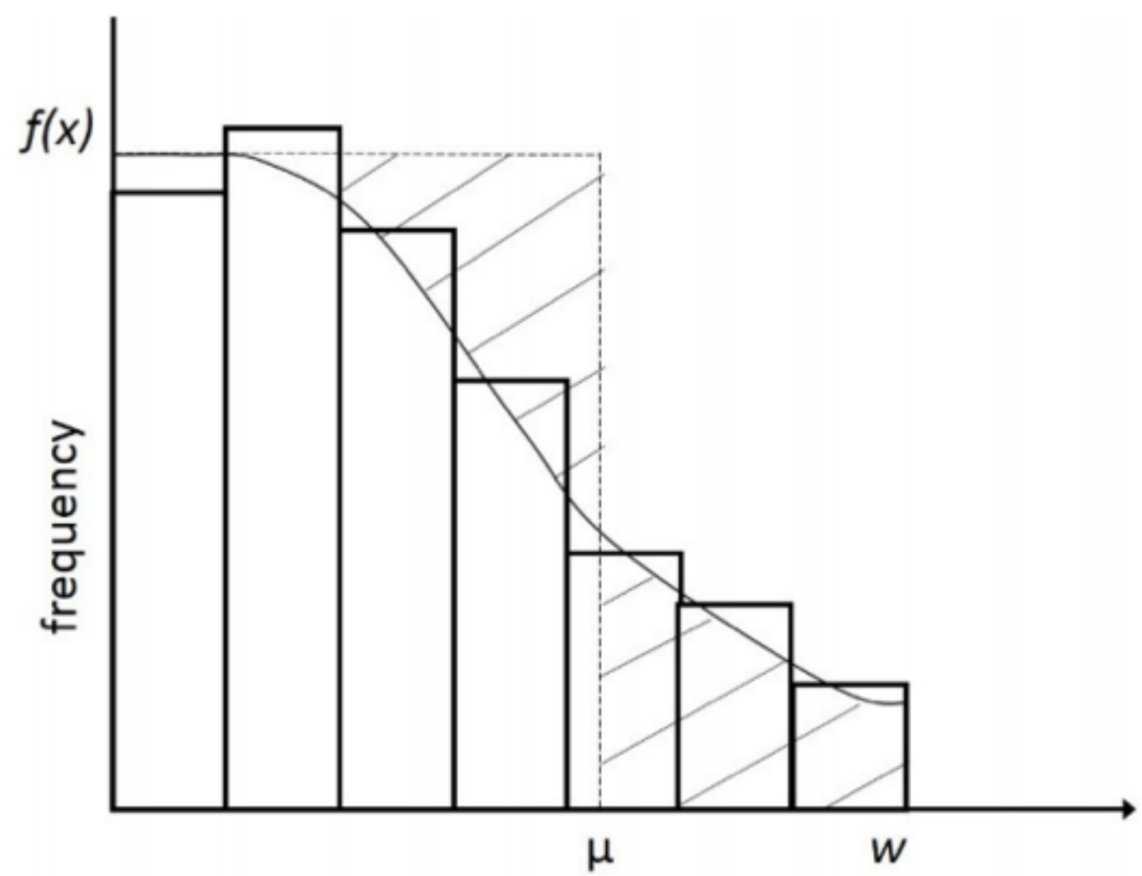
f(x) for line transect:



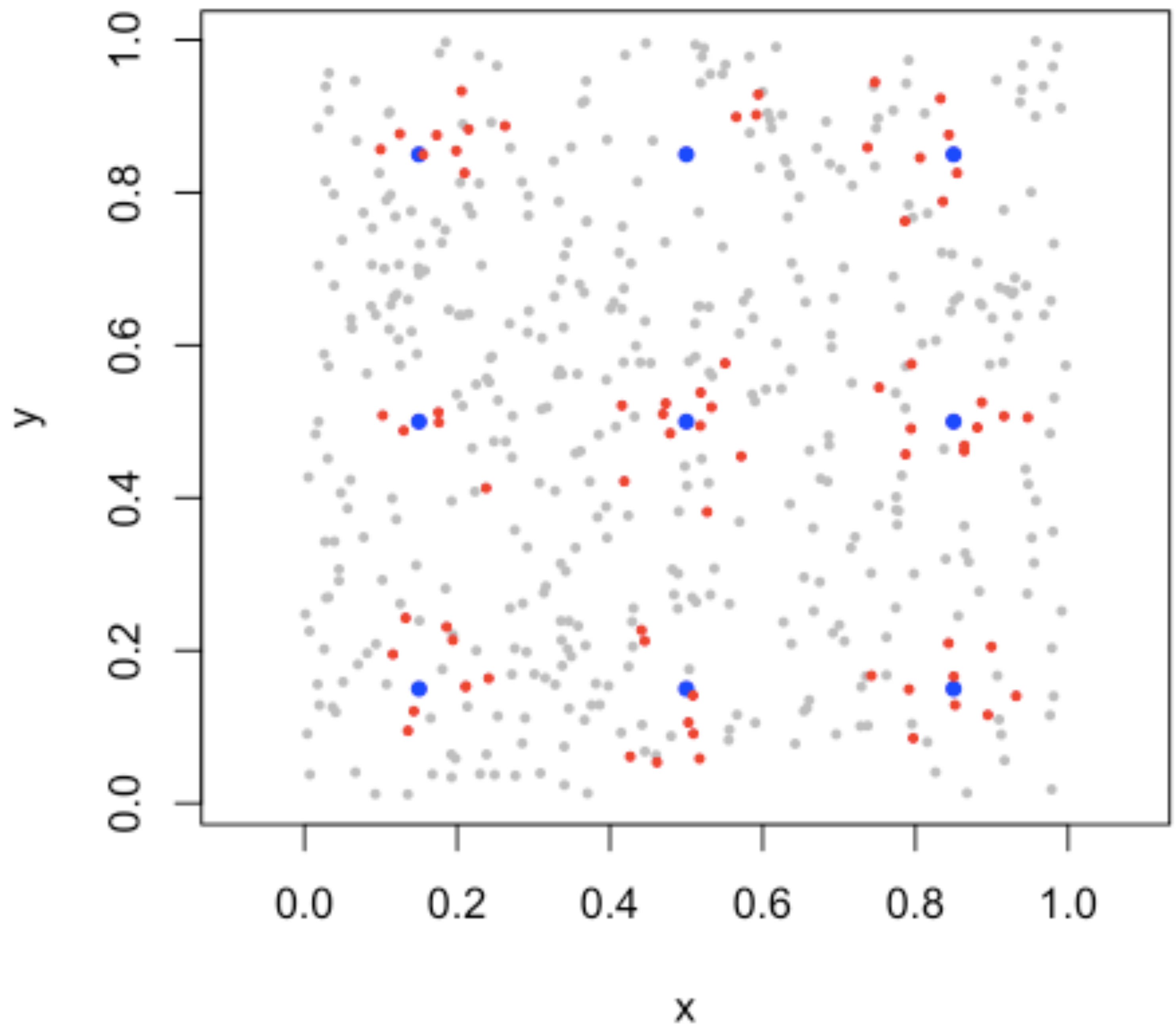
More animals detected closer to line than farther away

$$\hat{D} = \frac{n}{2w * \boxed{L*K} * \hat{P}}$$

Effort

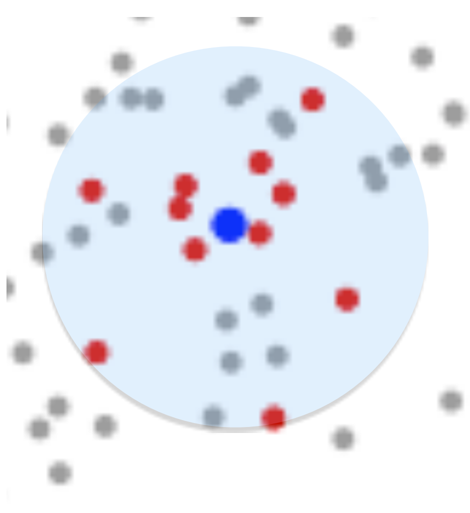


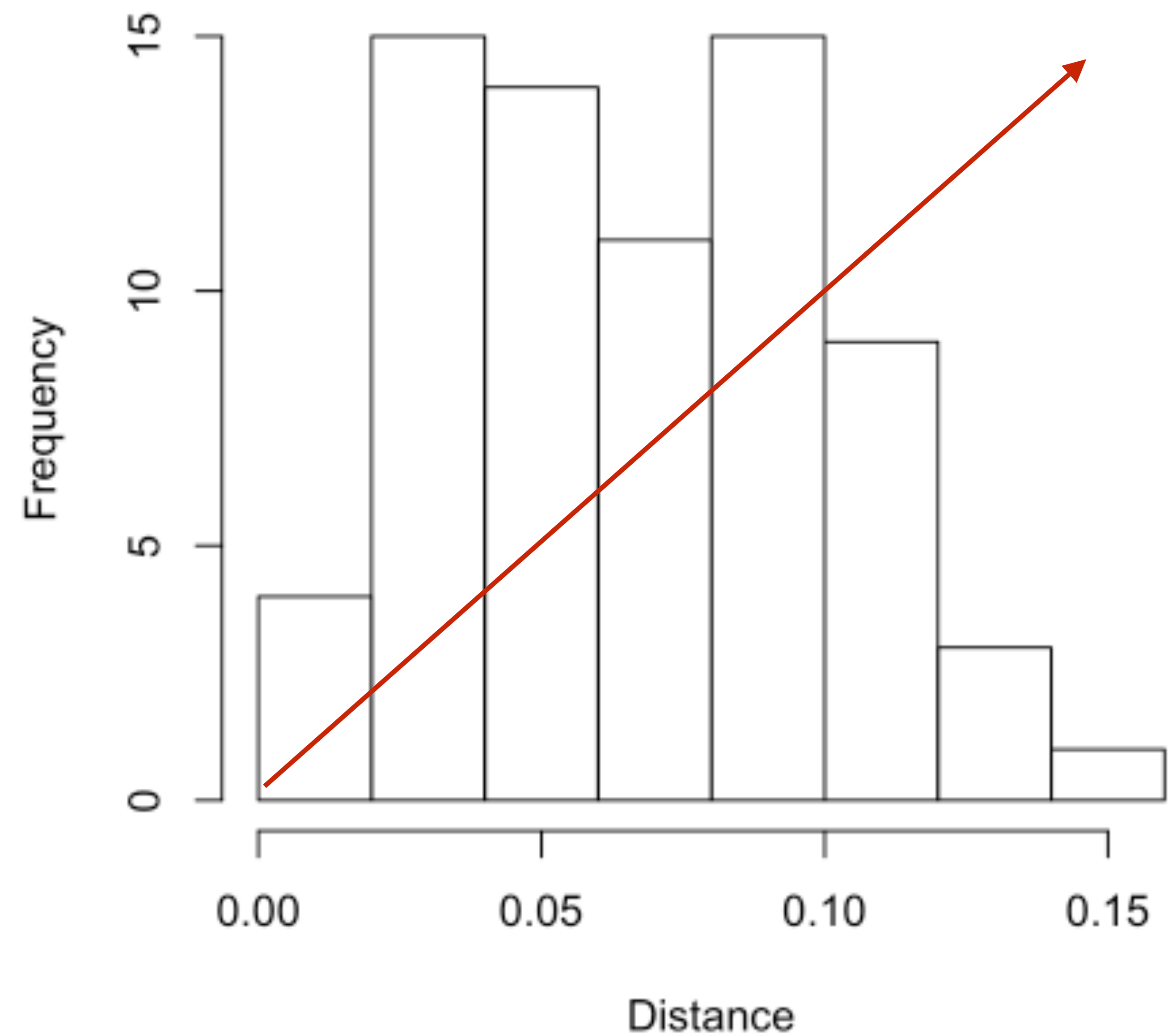
Could also count animals at points…



Could also count animals at points…

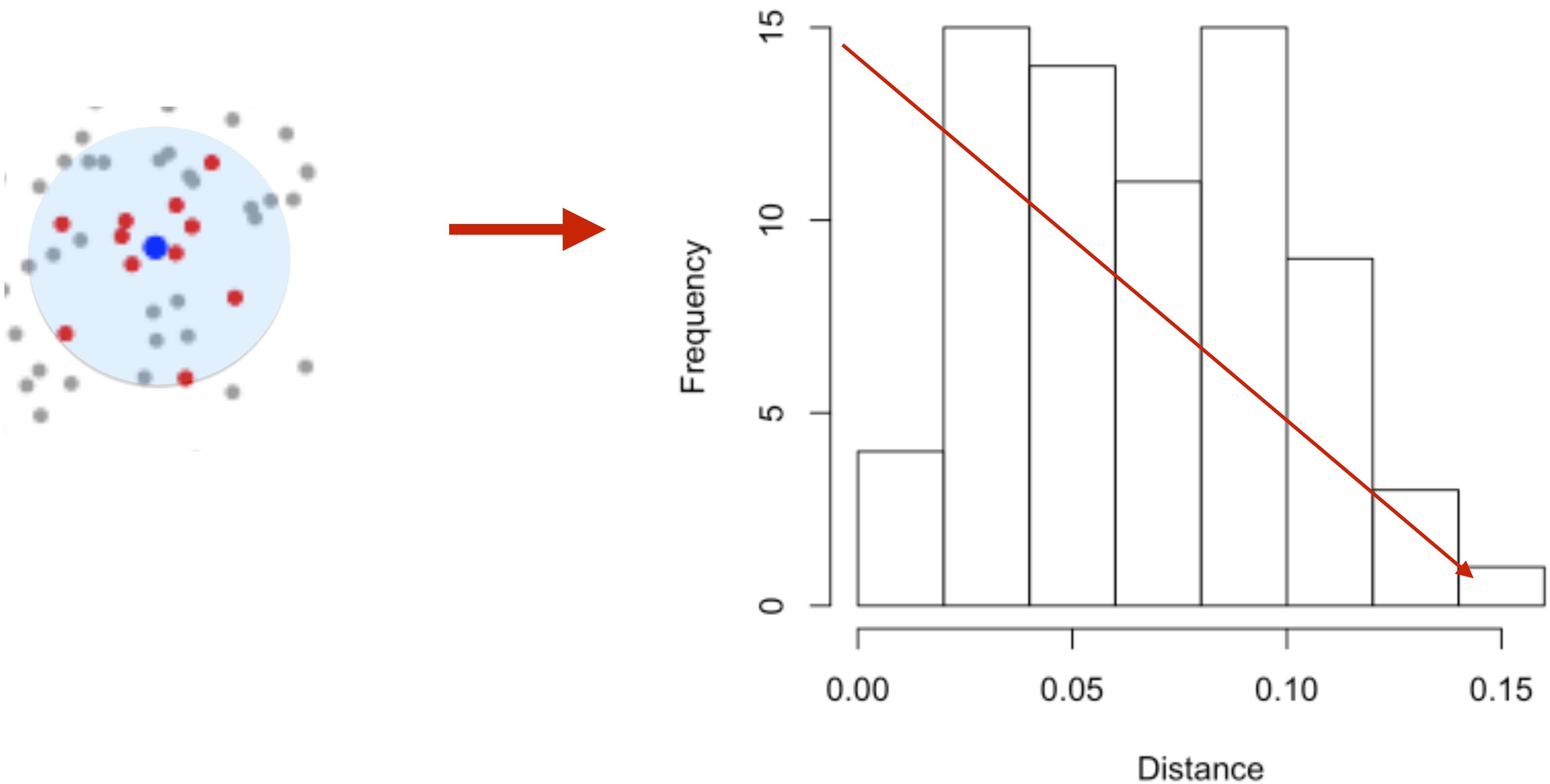
1) As the radius increases, the area surveyed increases – so there are more animals available to be detected. This increases quadratically (since the area of the circle is πr2).



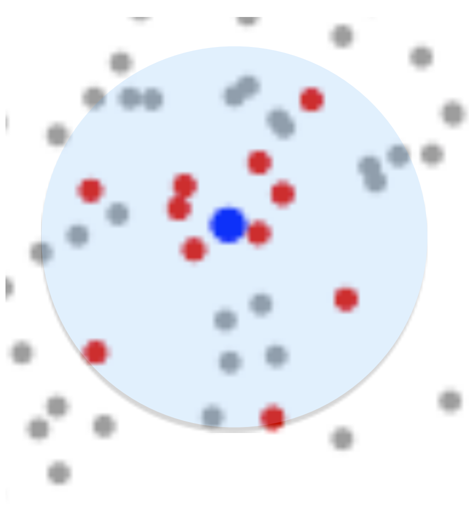


Could also count animals at points…

2) At the same time, we are increasing the distance from the point to the animals in question, this is the same problem as described for line transects: as animals are further away, they are harder to detect.



Could also count animals at points…

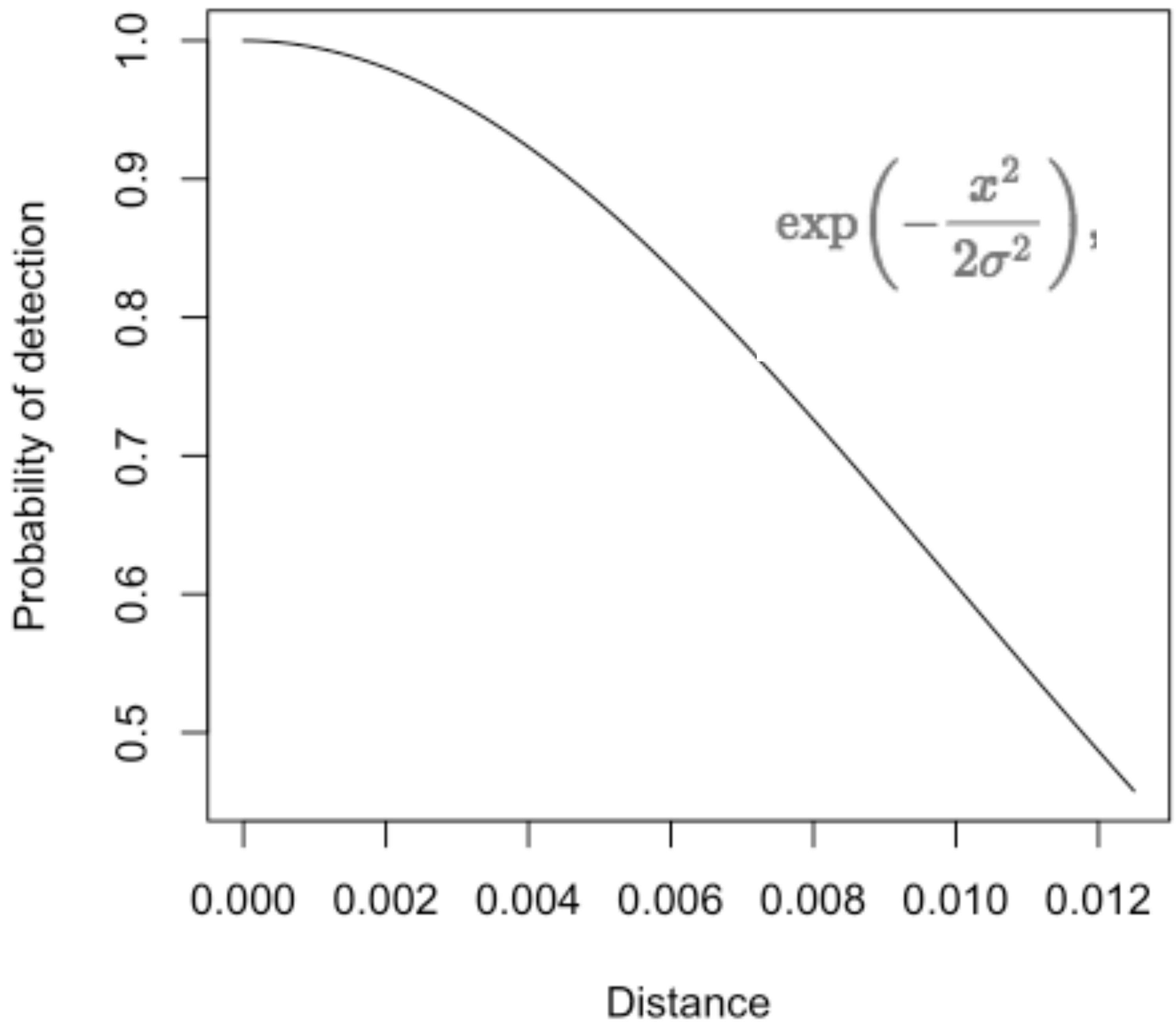


$$\hat{D} = \frac{n}{pi * w^2 * K * \hat{P}}$$

# of points

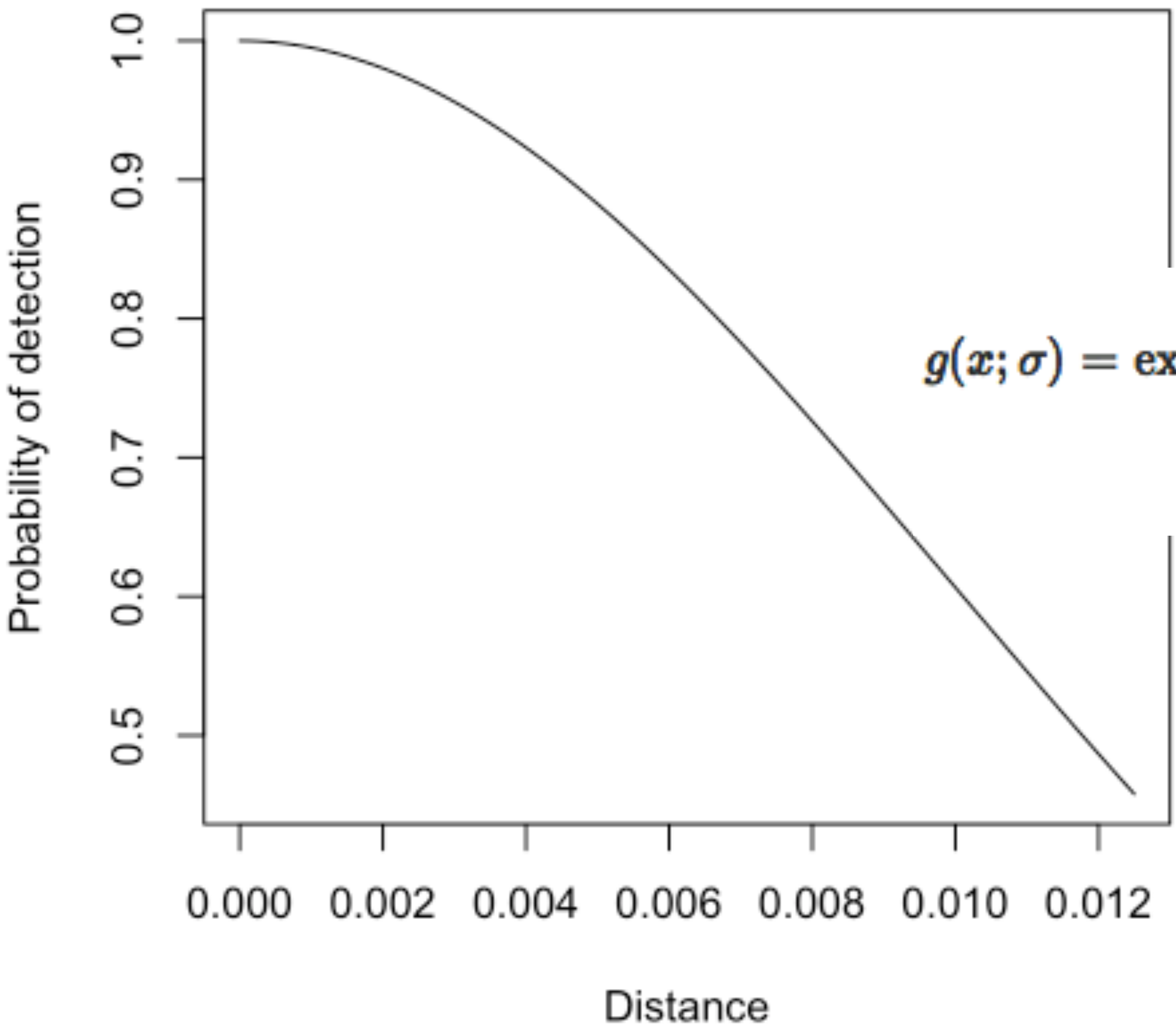
Functions for detectability ~ distance

The half-normal distribution



Functions for detectability ~ distance

The half-normal distribution

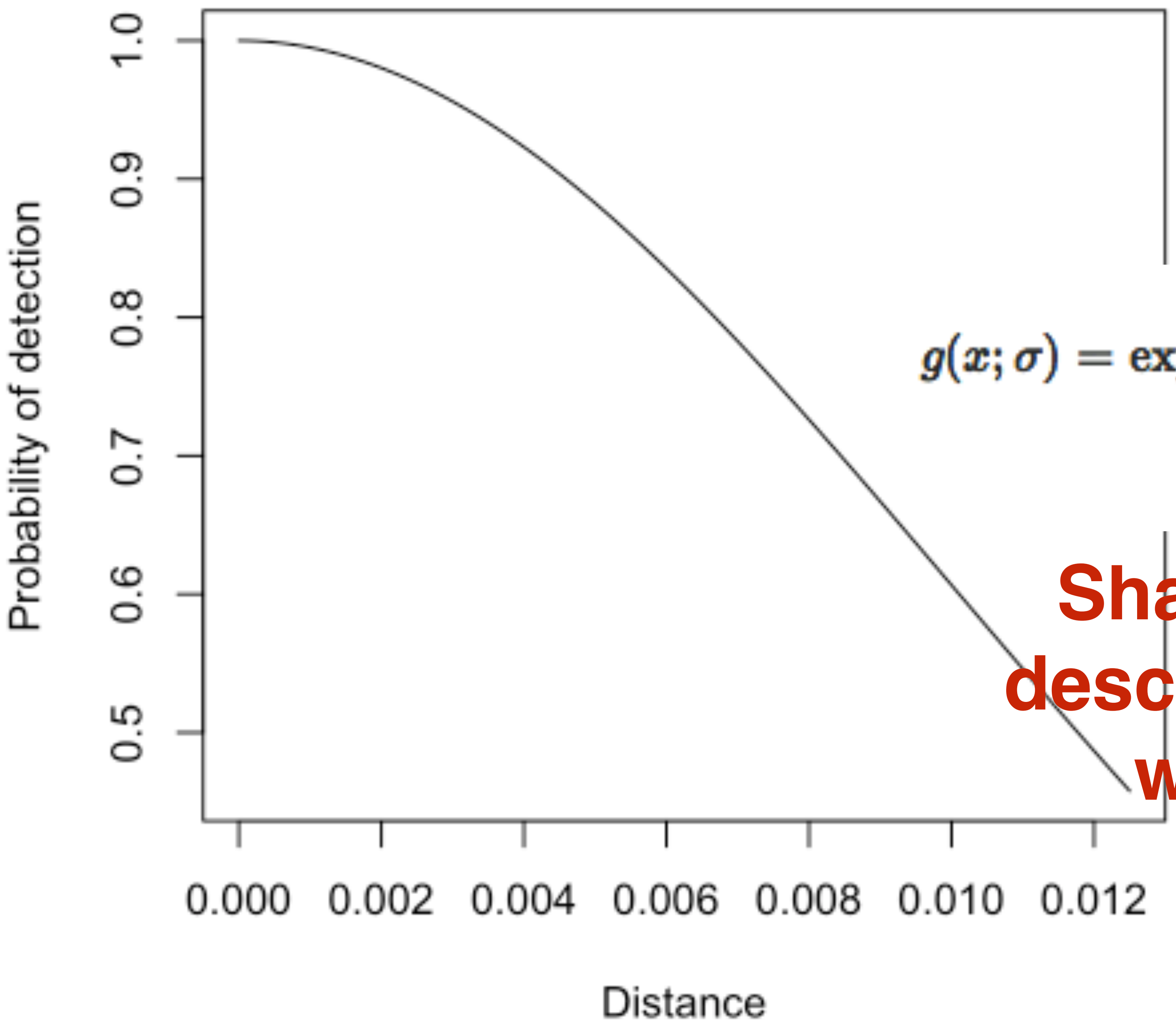


Perpendicular distance

$$g(x;\sigma) = \exp\left(-\frac{x^2}{2\sigma^2}\right)$$

Functions for detectability ~ distance

The half-normal distribution

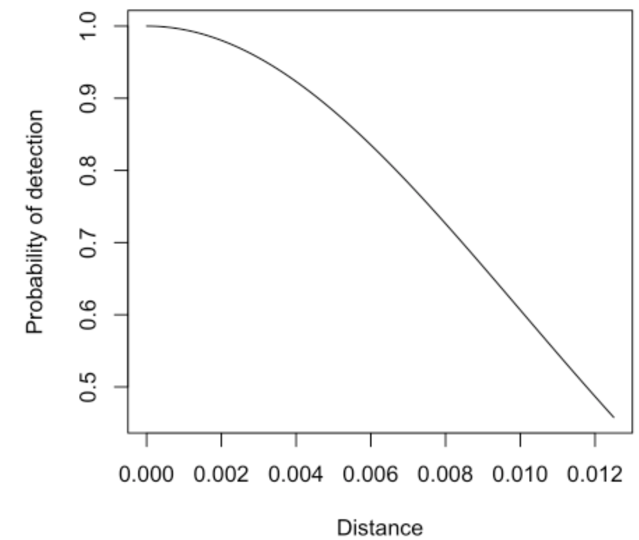


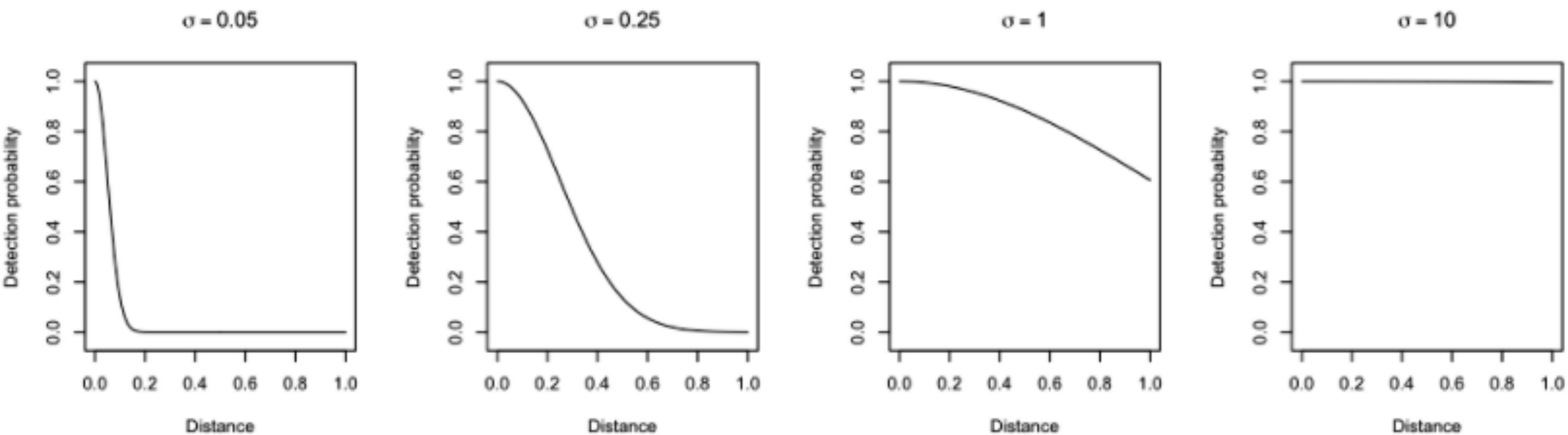
$$g(x;\sigma) = \exp\left(-\frac{x^2}{2\sigma^2}\right)$$

Shape parameter, describes how likely we are to see an animal at a given distance

Functions for detectability ~ distance

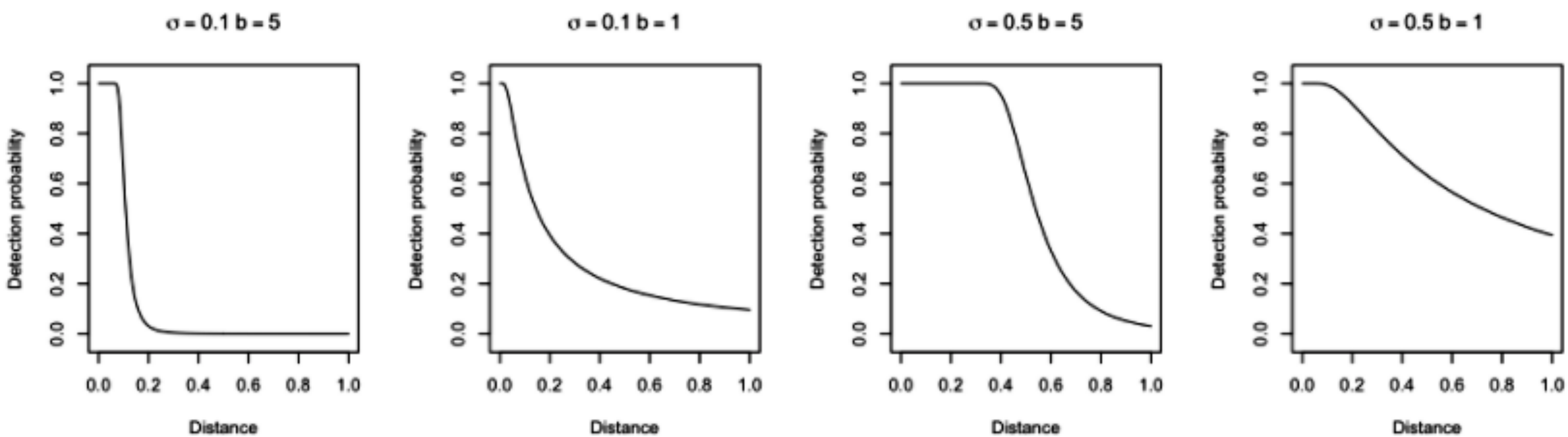
The half-normal distribution $$g(x;\sigma) = \exp\left(-\frac{x^2}{2\sigma^2}\right)$$





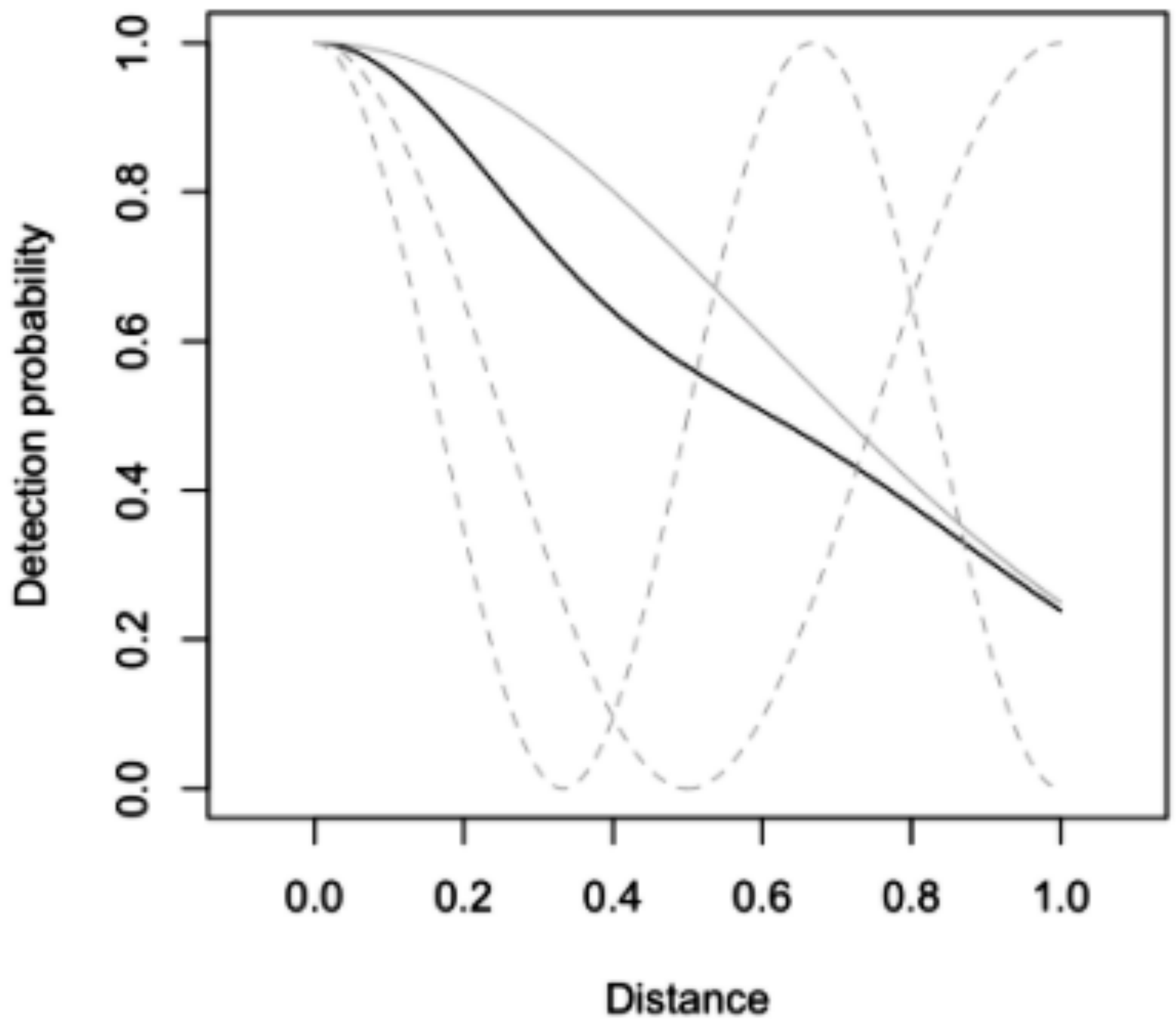
Functions for detectability ~ distance

The hazard distribution $g(x;\sigma,b) = 1 - \exp\left(-\left(\frac{x}{\sigma}\right)^{-b}\right).$



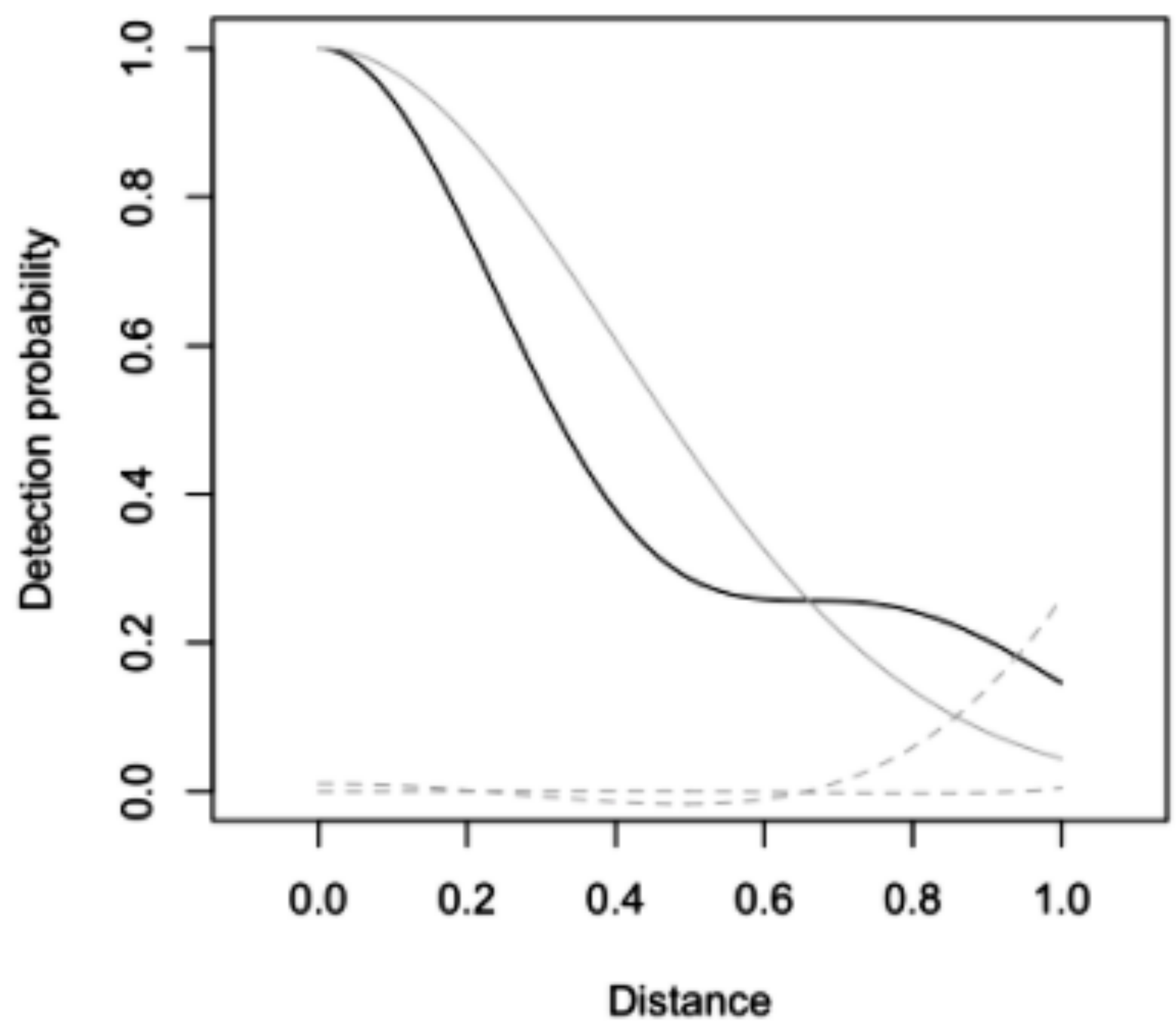
Adjustments to detection functions: K + A

The cosine adjustment



Adjustments to detection functions: K + A

Cosine adjustment allows for lots of shapes
Also many other detection and adjustment functins



The simple polynomial adjustment

What types of sampling does this cover?

- line transect sampling, in which the distances sampled are distances of detected objects (usually animals) from the line along which the observer travels

- point transect sampling, in which the distances sampled are distances of detected objects (usually birds) from the point at which the observer stands

- cue counting, in which the distances sampled are distances from a moving observer to each detected cue given by the objects of interest (usually whales)

- migration counts, in which the ‘distances’ sampled are actually times of detection during the migration of objects (usually whales) past a watch point

Tracey J. introduces Coon Creek data set

Coding Challenge