Line Transect Sampling

A Brief History

Date | **Mark-Recapture (MR)** | **Line Transect (LT)**

[redacted]

1900

[redacted]

1940

[redacted]

[redacted]

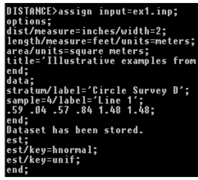
1970

1980

1990

2000

Software



[redacted]

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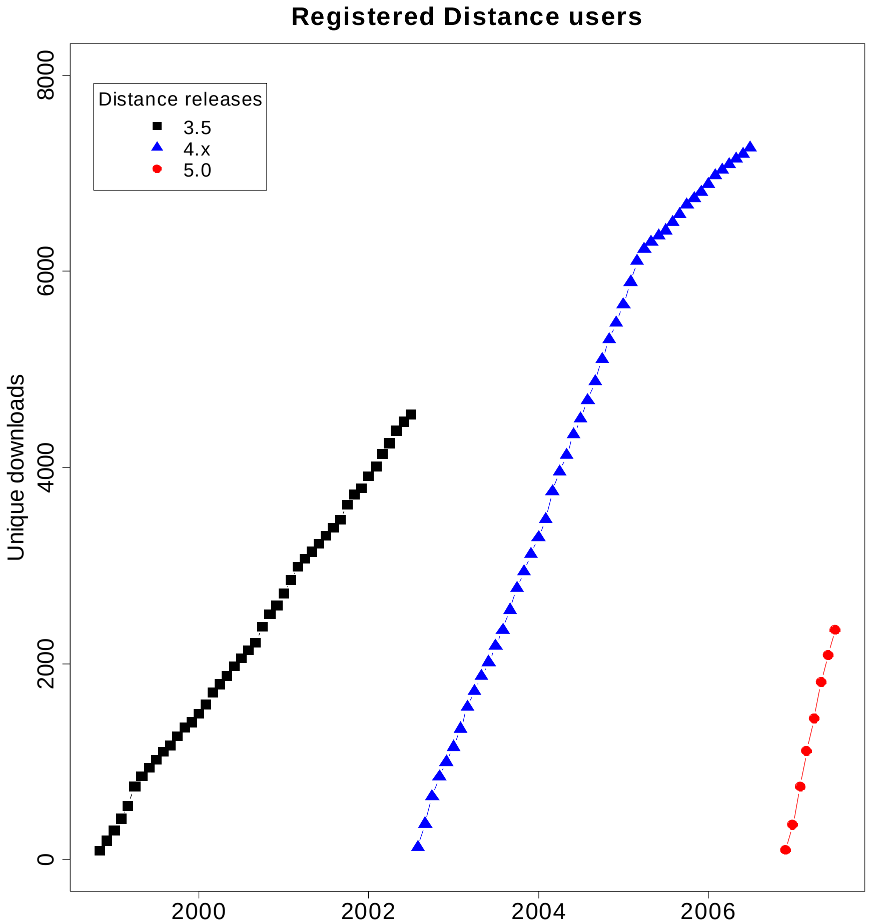
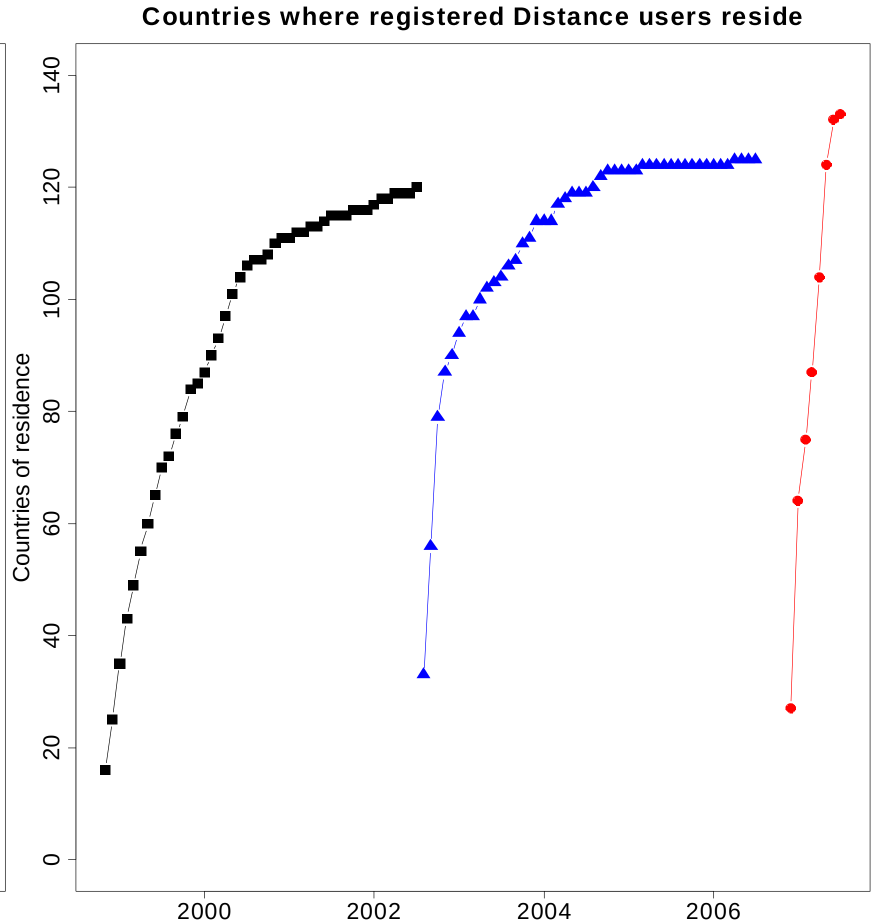
DISTANCE 4

DISTANCE 5

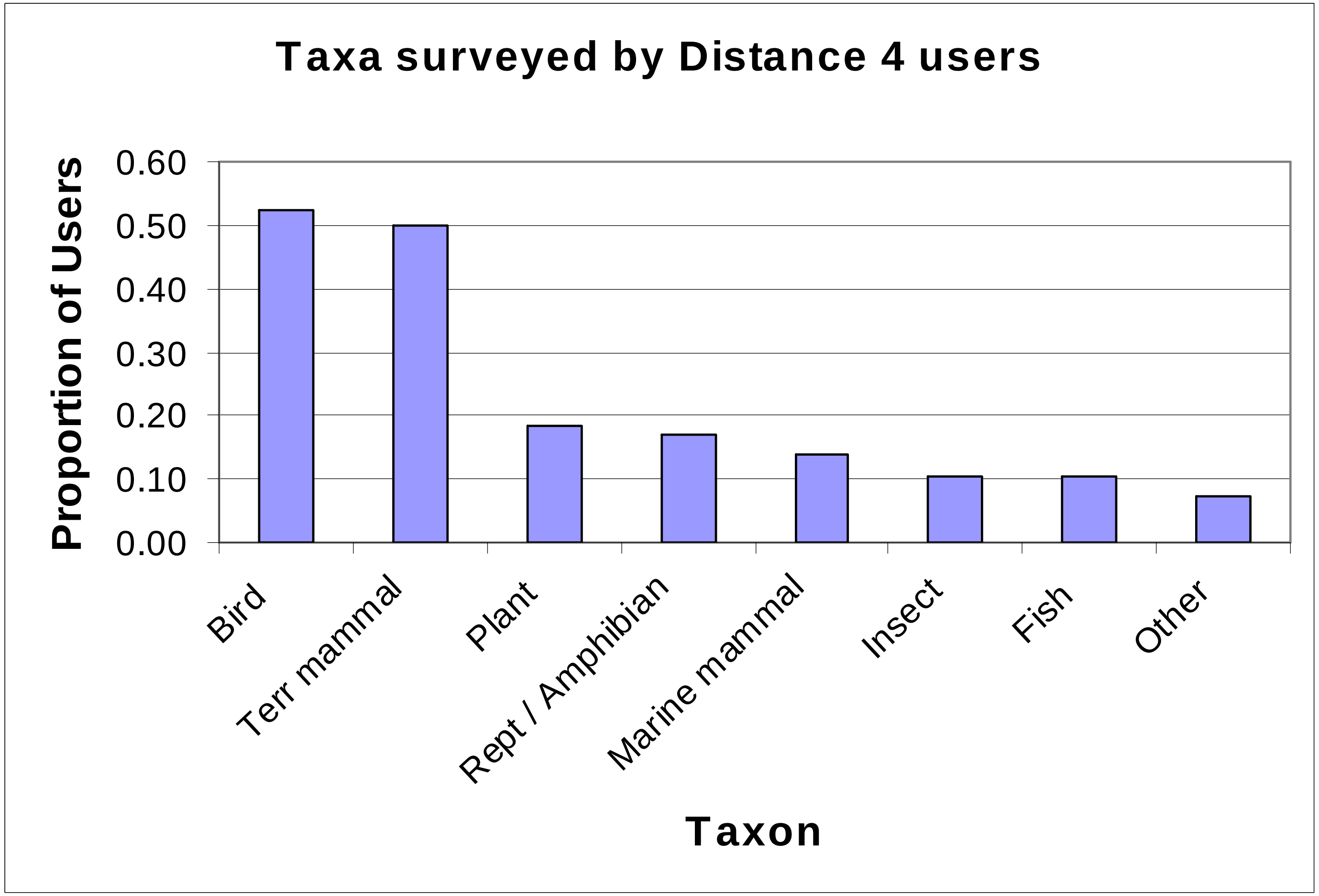
DISTANCE 6

Distance Users

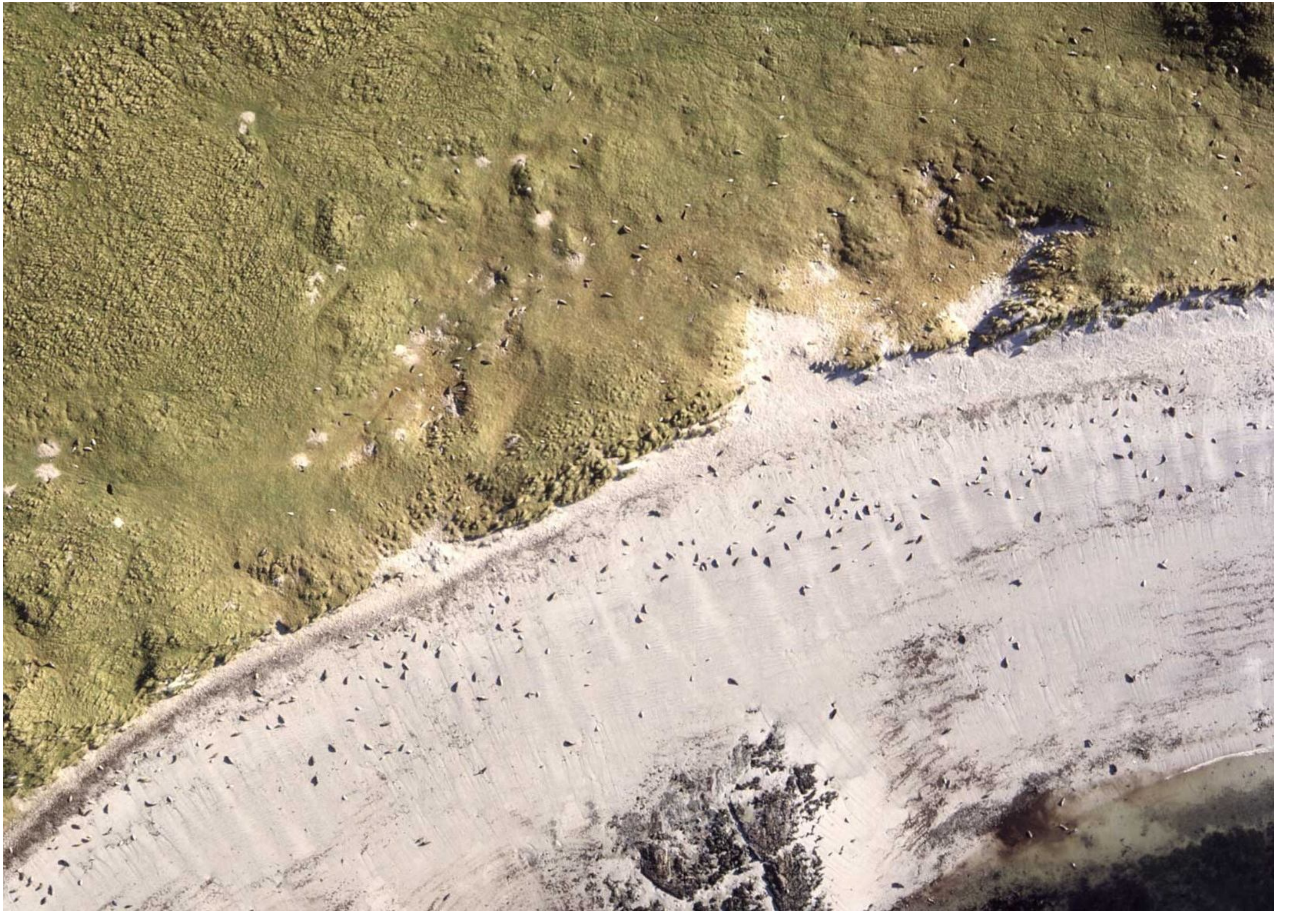




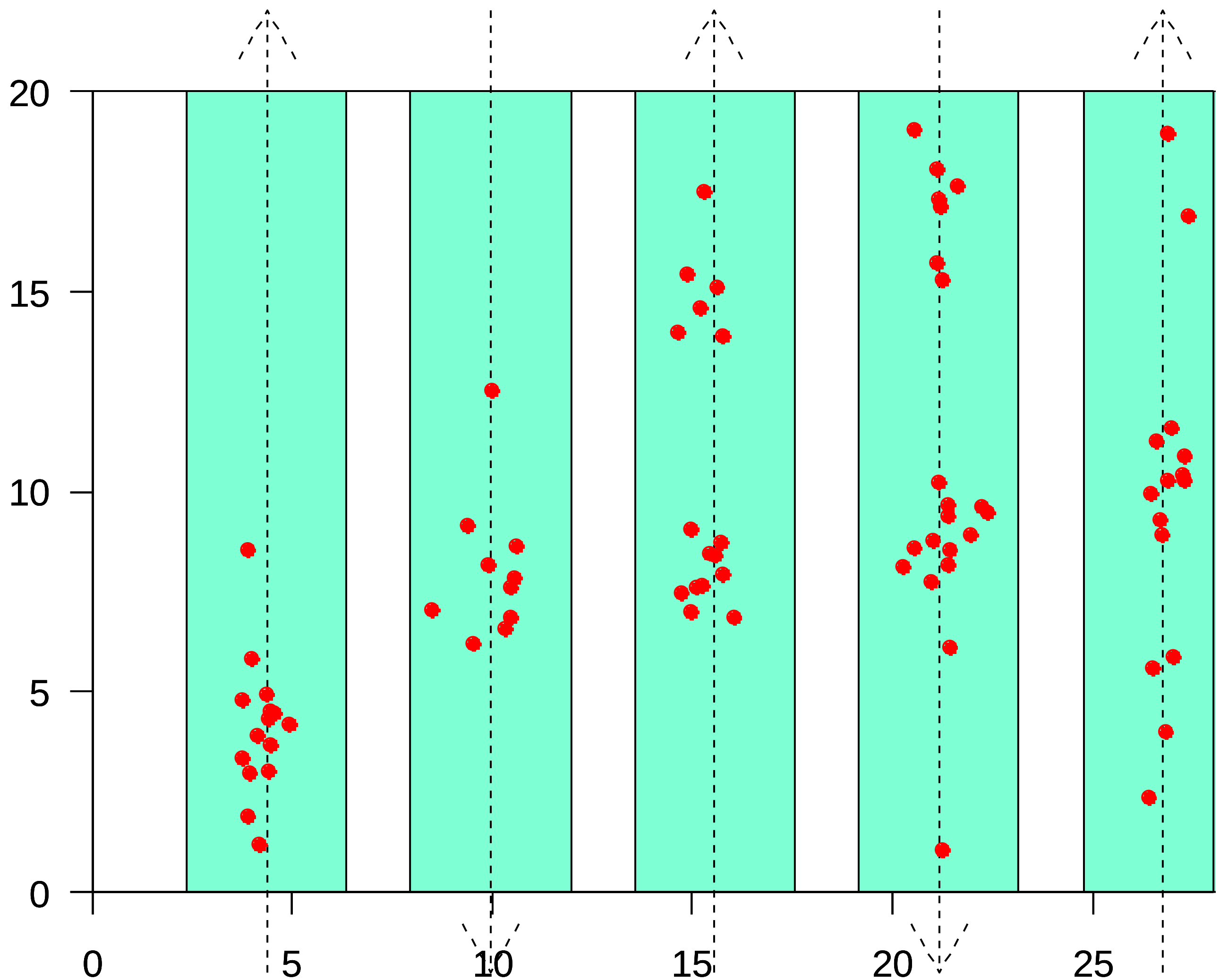
Distance Users



Simple Example



Example strip transect survey



Strip Transect Estimator

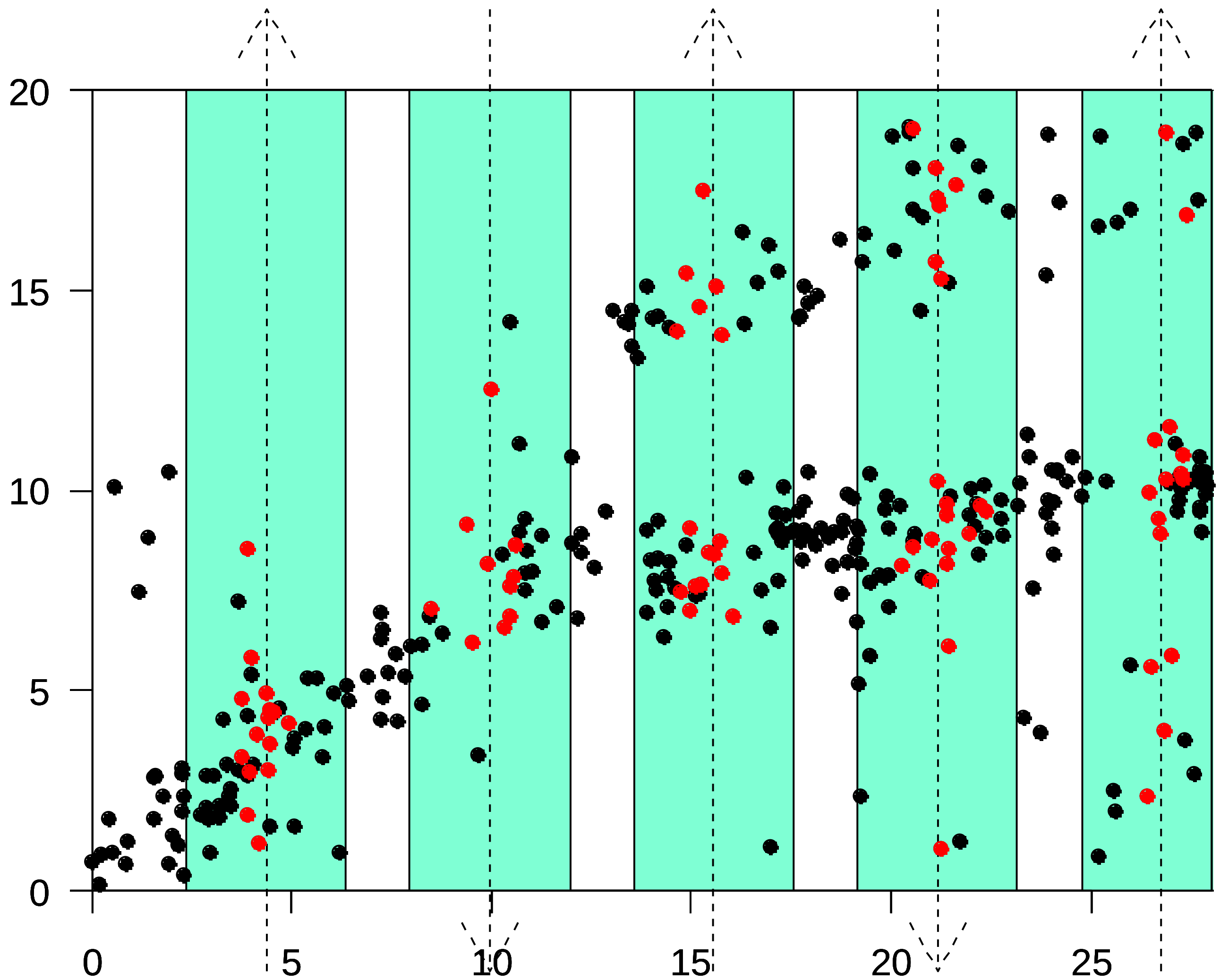
- N_c is the number of animals in the covered region
  - I saw $n=N_c=80$ animals.

- Area of Strips is a; Area of Survey Region is A; (a/A=0.8)

- Standard Hotwitz-Thompson Estimator of the number in the survey region uses the number in the covered region and proportion of survey region which is covered :

$$\hat{N} = \frac{n}{\left(\frac{a}{A}\right)} = \frac{80}{0.8} = 100$$

Example line transect survey



Line Transect Estimator

- **Step 1:** Estimate N_c, number of animals in the covered region
  - I saw n=80 animals.
  - I (somehow) estimate probability of detecting animals in the covered region to be p=0.55. Hence Horwitz-Thompson-like estimator:

$$\hat{N}_c = \frac{n}{p} = \frac{80}{0.55} = 145$$

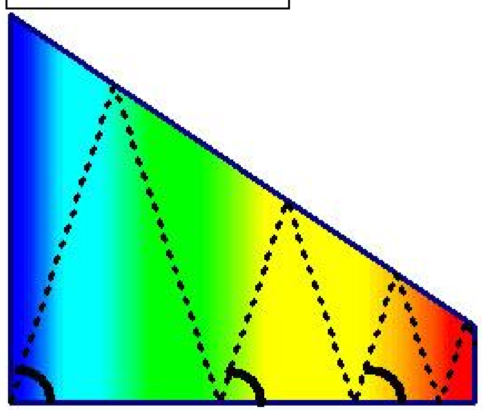
- **Step 2:** Estimate the number in the survey region (N) using the estimated number in the covered region as before:

$$\hat{N} = \frac{\hat{N}_c}{\left(\frac{a}{A}\right)} = \frac{145}{0.8} = 182$$

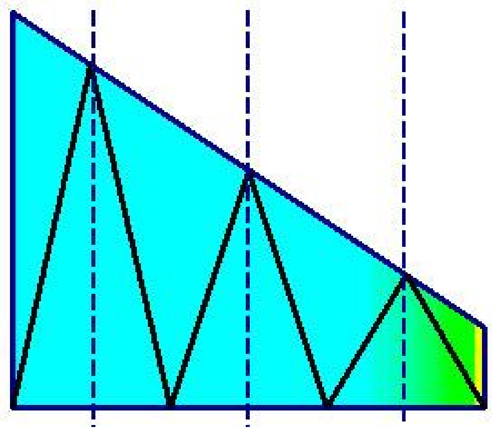
Some Design Issues

- Equal coverage probability is design-unbiased (no matter what animal distribution).
- Parallel line design (and others) gives equal coverage.
- Zig-zag may not give equal coverage.
- Stratifying improves precision.
- Can make coverage equal, or build unequal coverage into estimation.

Equal Angle



Equal Waypoint Distance



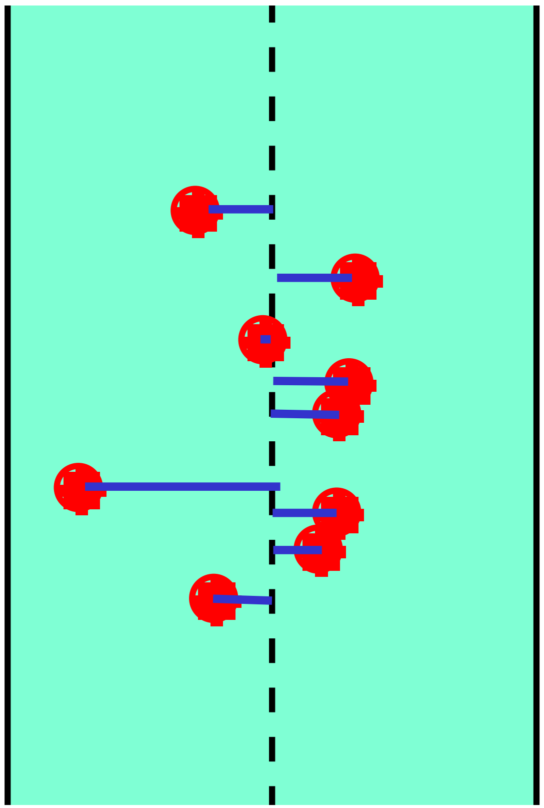
Line Transect Estimator

- Estimation of p is crucial.

- Where does p come from?

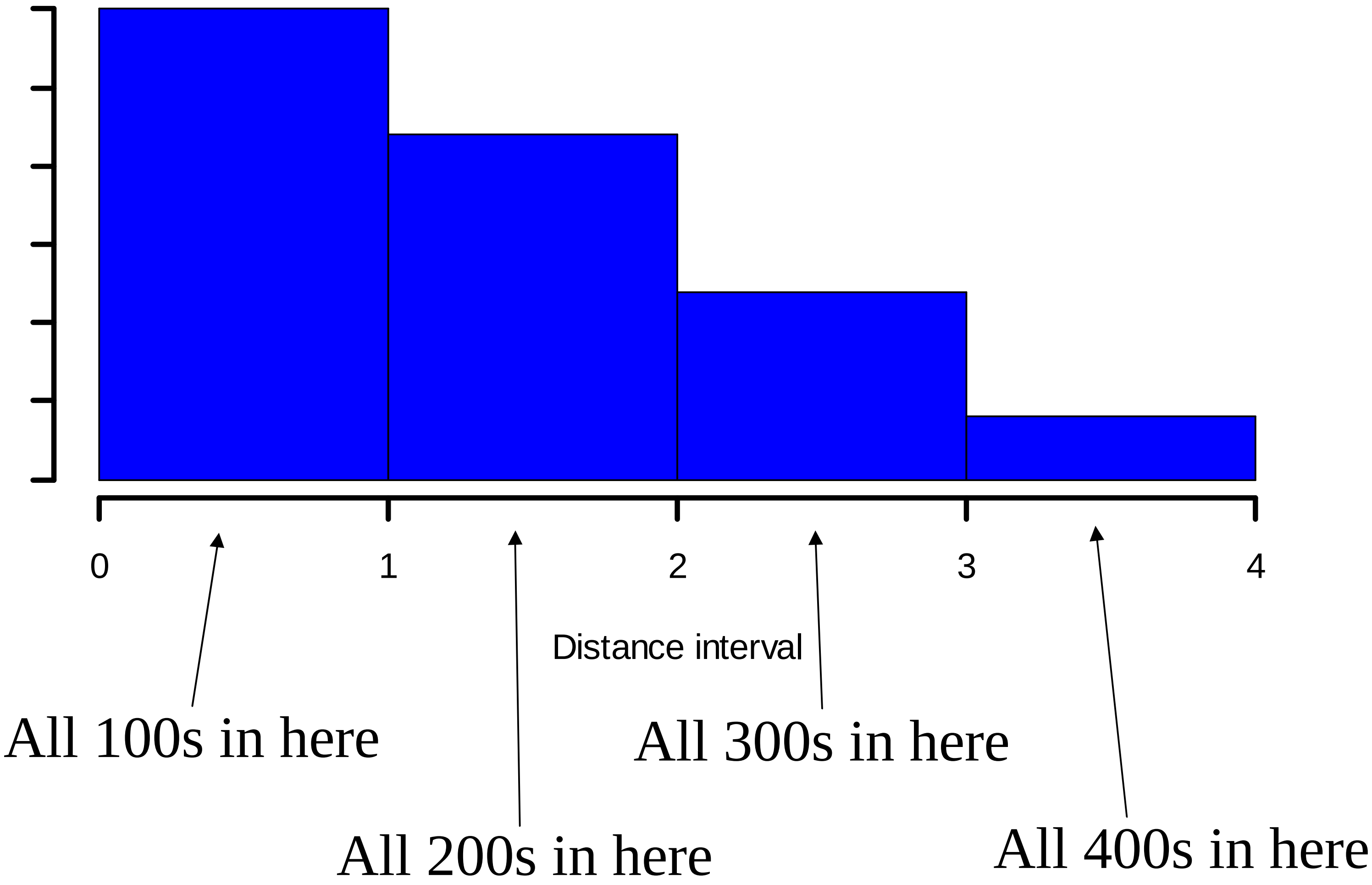
Estimating *p*

Record perpendicular distance, *x*, from transect line to each observed object

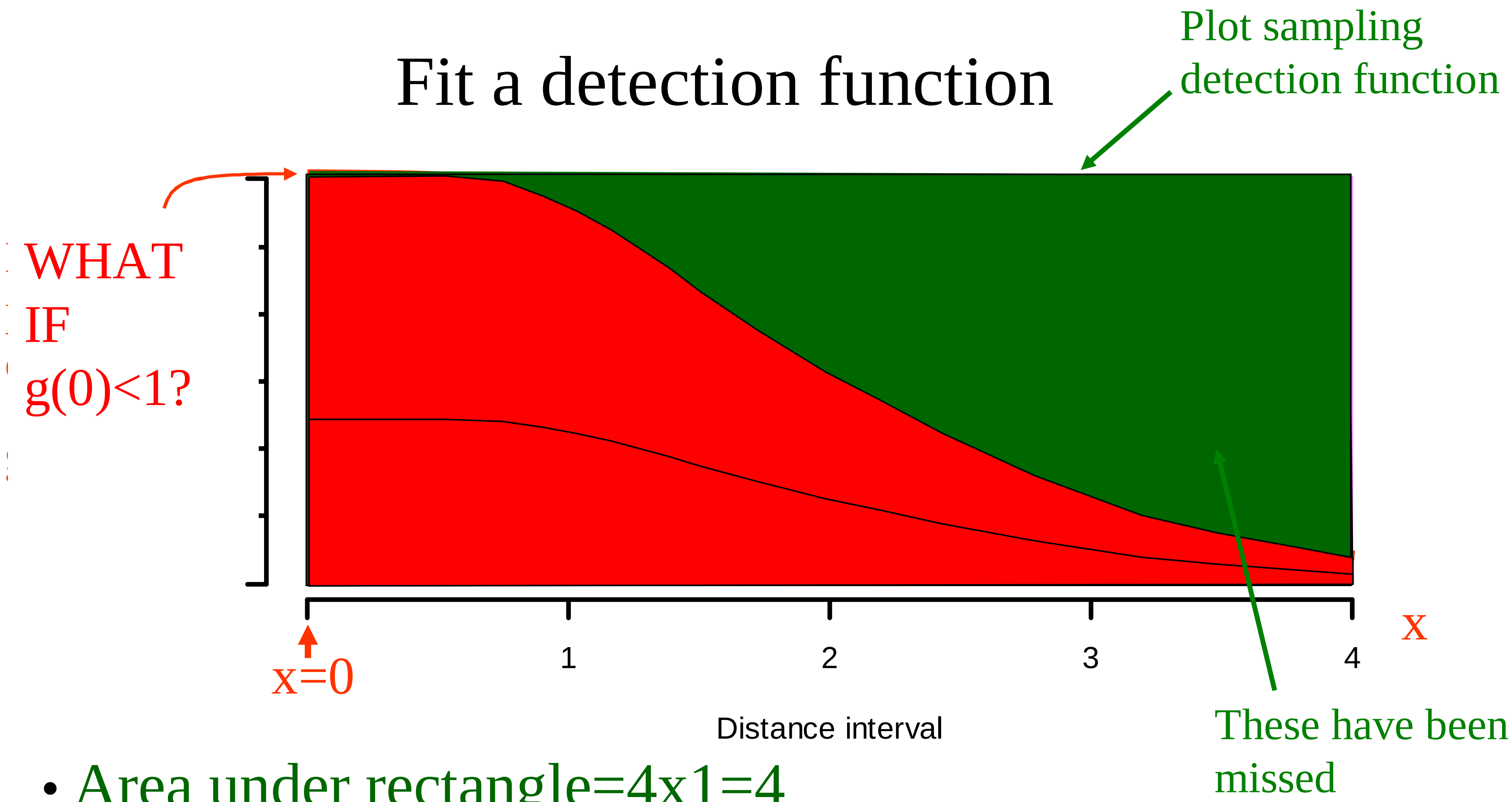


Draw a histogram

Class example distances are encoded in the numbers

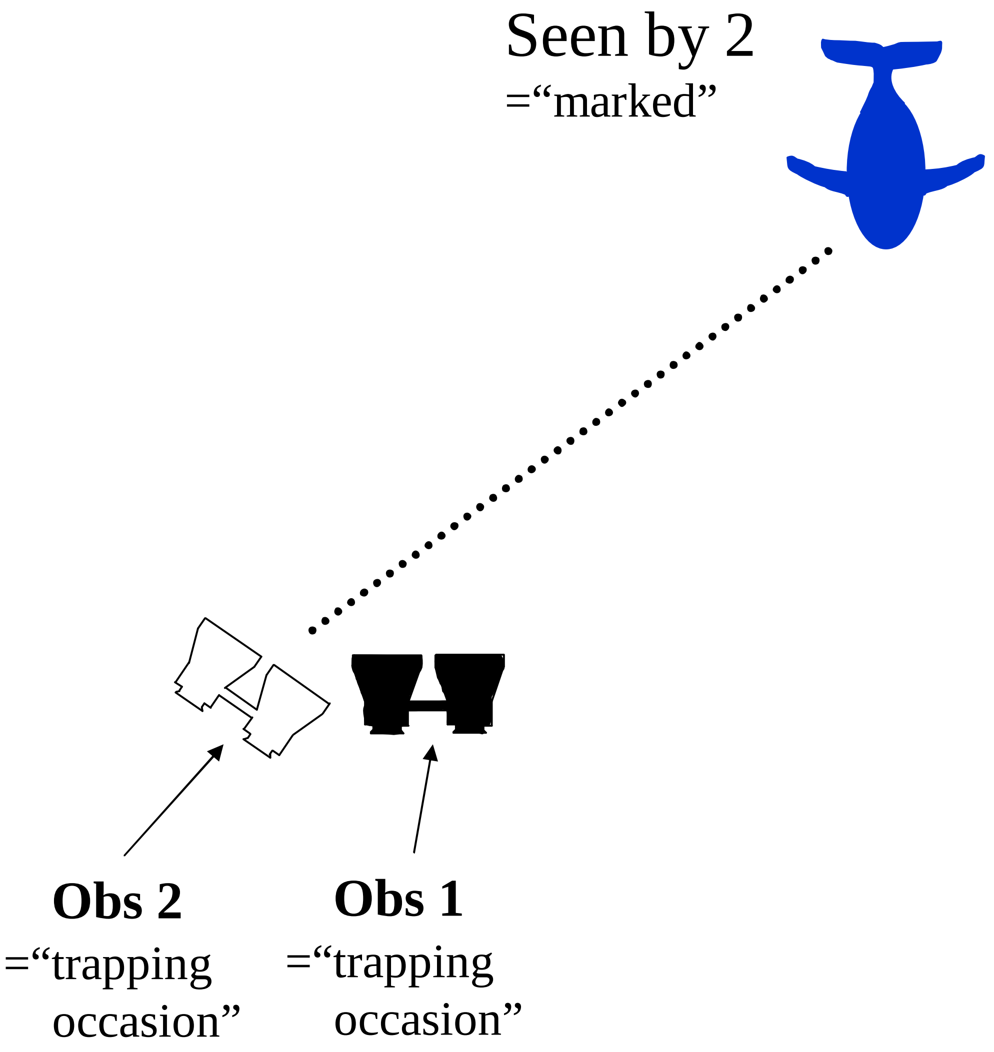


Fit a detection function

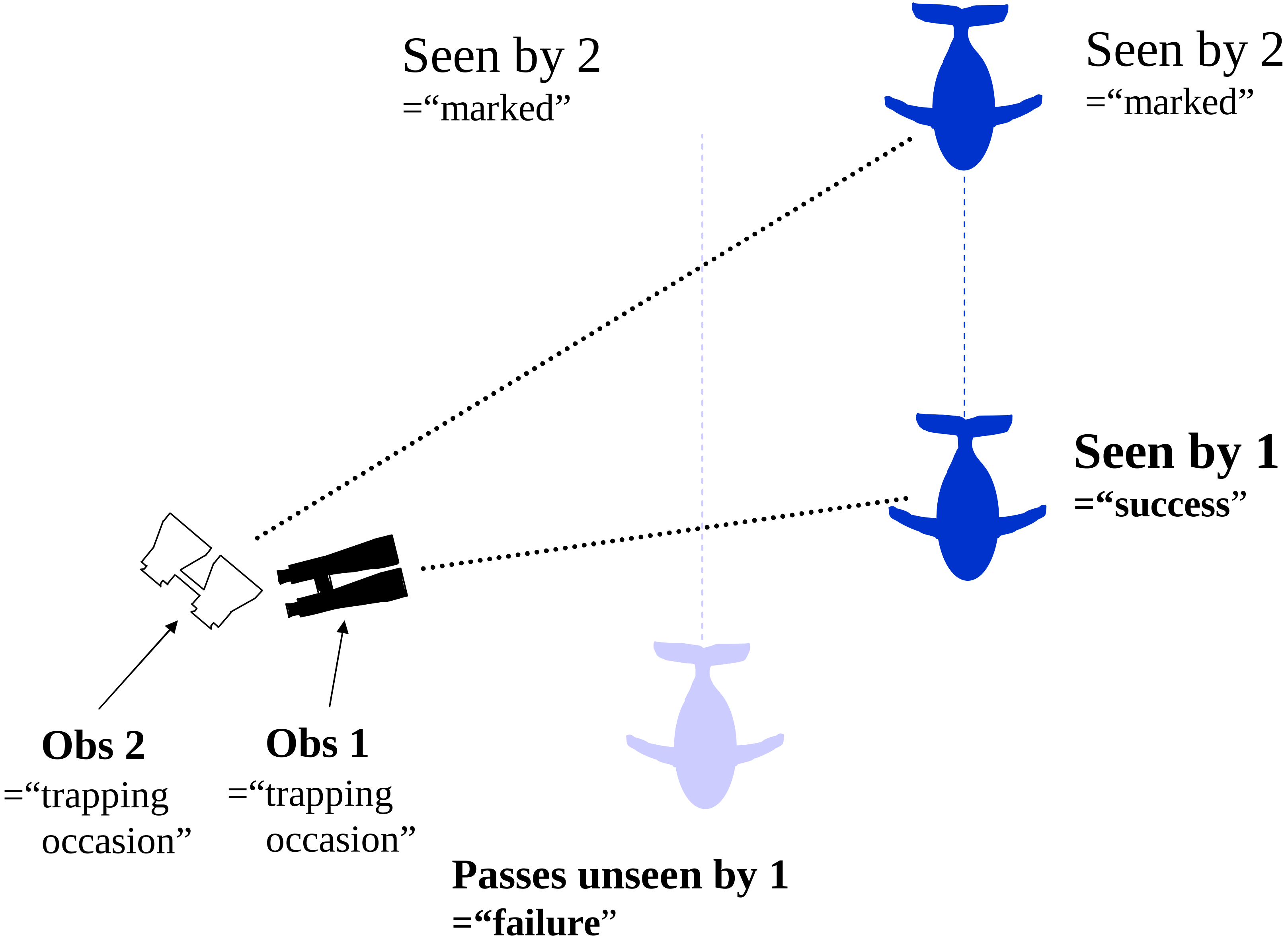


- Area under rectangle=4x1=4
- Area under curve = 2.2
- Therefore estimate proportion seen $\hat{p} = \mathbf{2.2} / \mathbf{4} = 0.55$

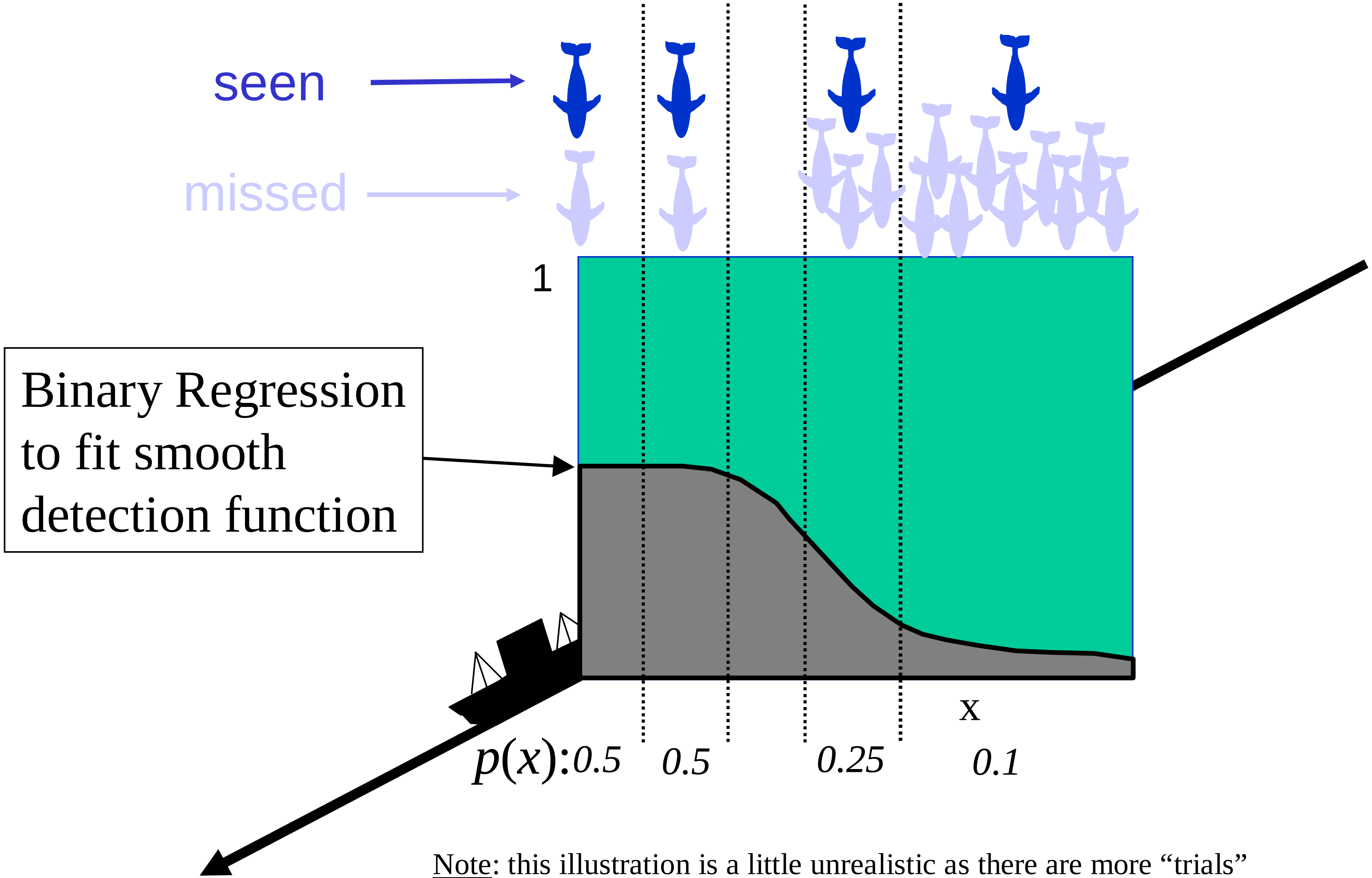
Visual Mark-Recapture



Visual Mark-Recapture

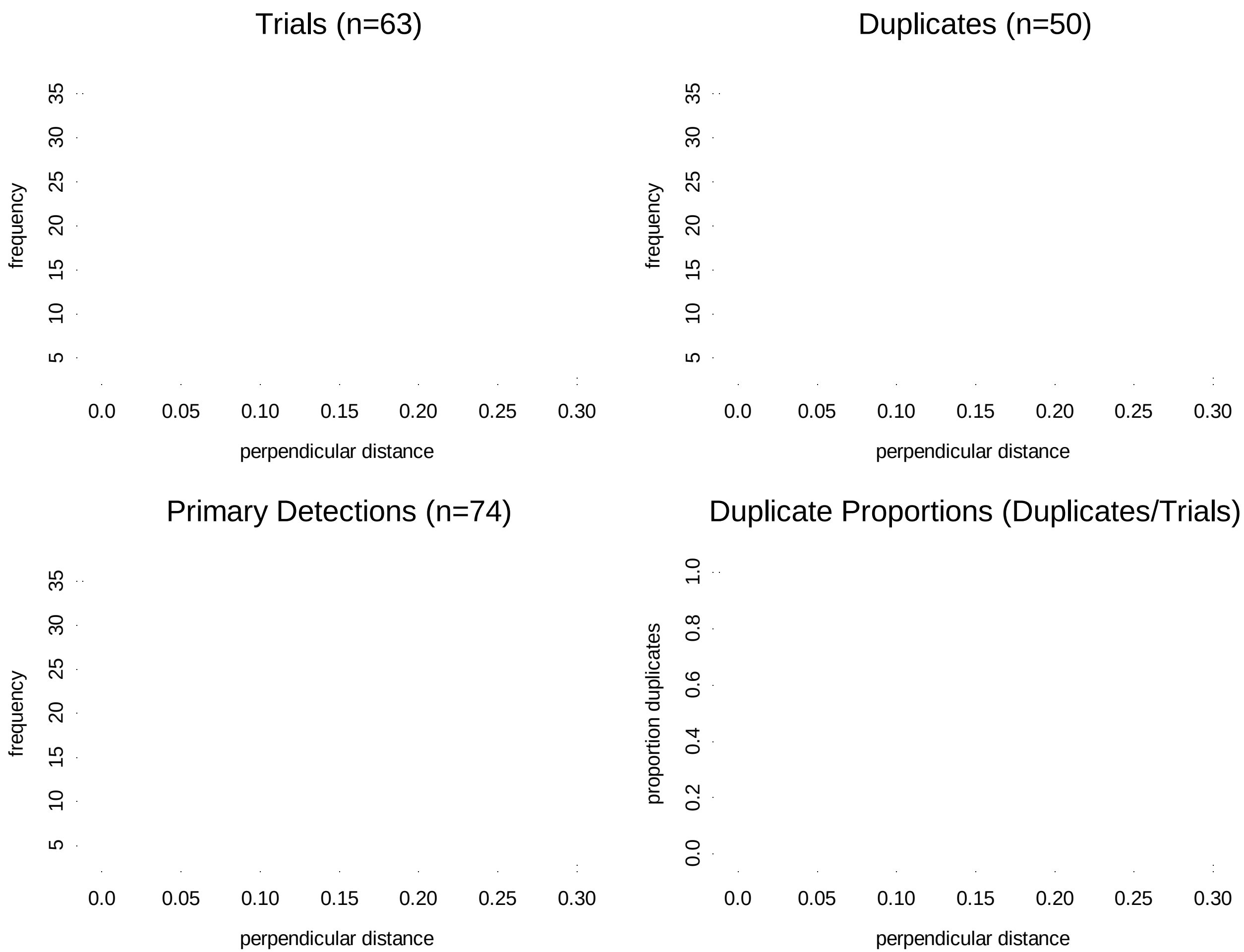


Treat as Mark-Recapture data with distance (x) as covariate



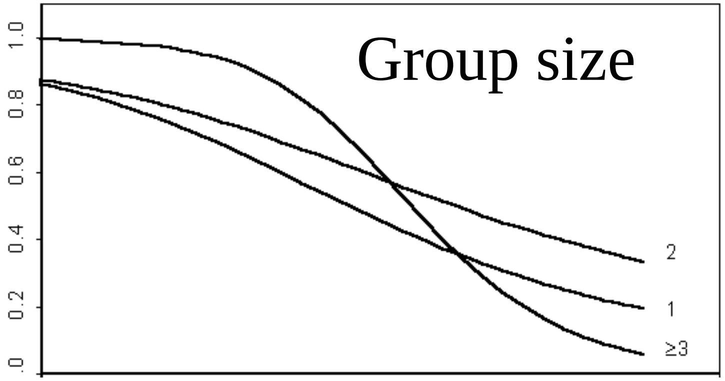
Note: this illustration is a little unrealistic as there are more "trials" at larger distances. (Not a problem, but unlikely to happen.)

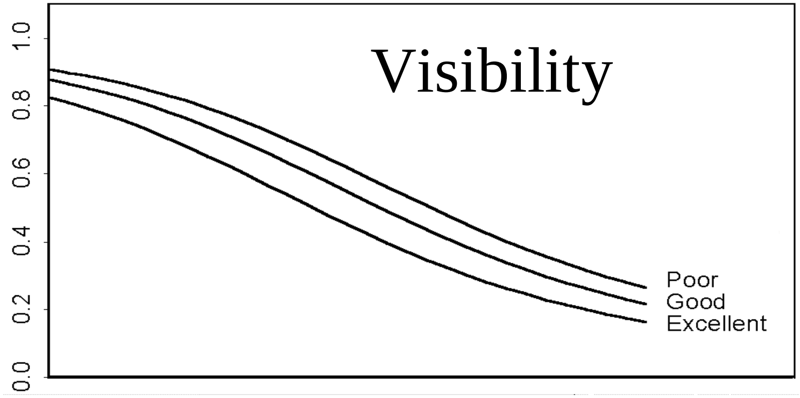
Common Dolphins in Atlantic

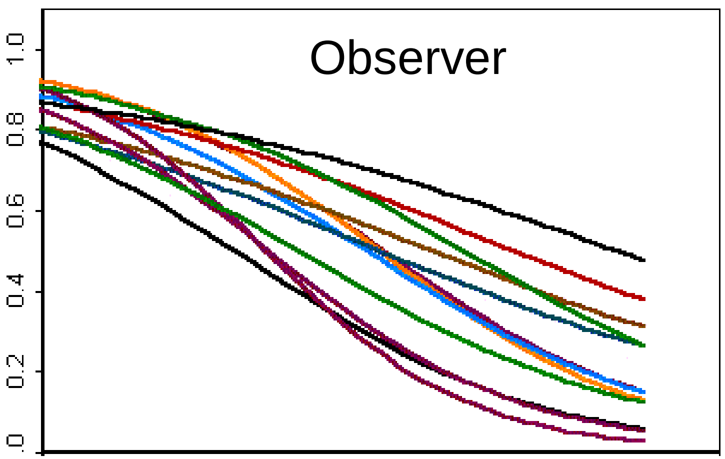


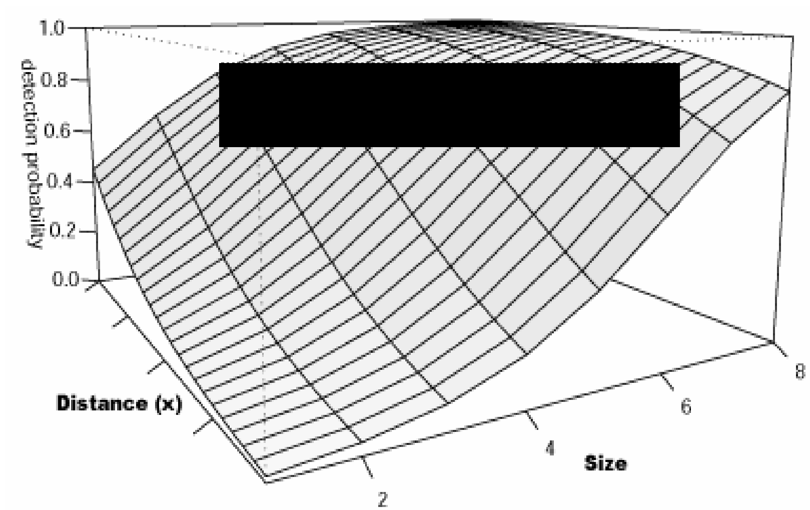
Things affecting detection probability

(Sources of Heterogeneity)



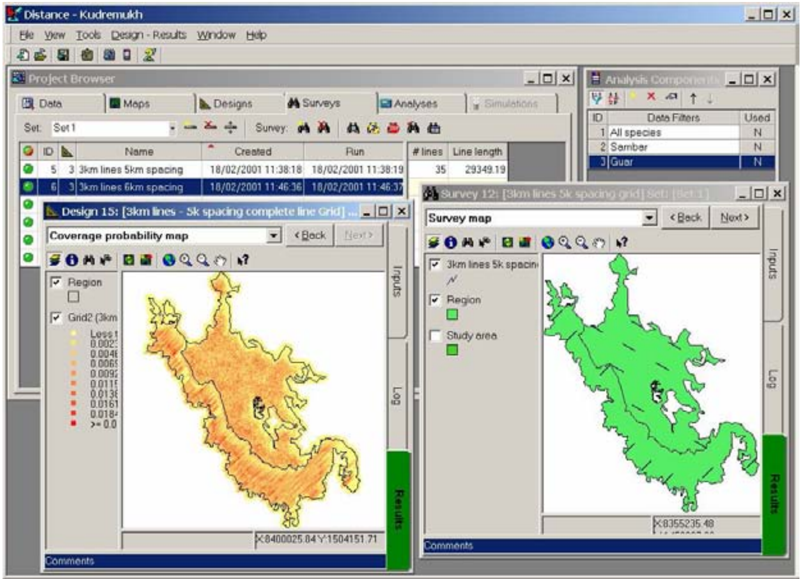






Some Recent Developments

Automated Design and Unequal Coverage Estimators



|Density Surface Modelling (Random design not essential)