Animals in groups (clusters)

See also

- Section 3.5 of Buckland et al. (2001)
- Section 3.3.3.2 of Buckland et al. (2004)
- Section 6.3.1.3 of Buckland et al. (2015)

Clustered populations

$$\hat{D} = \hat{D}_s \times \hat{E}(s)$$

Density of clusters

Mean cluster size

$$\left[cv(\hat{D})\right]^2 = \frac{\widehat{Var}(\hat{D})}{\hat{D}^2} \approx [cv(\text{encounter rate})]^2 + [cv\{\text{detection function}\}]^2 + [cv\{\text{cluster size}\}]^2$$

Bias in estimation of average group size

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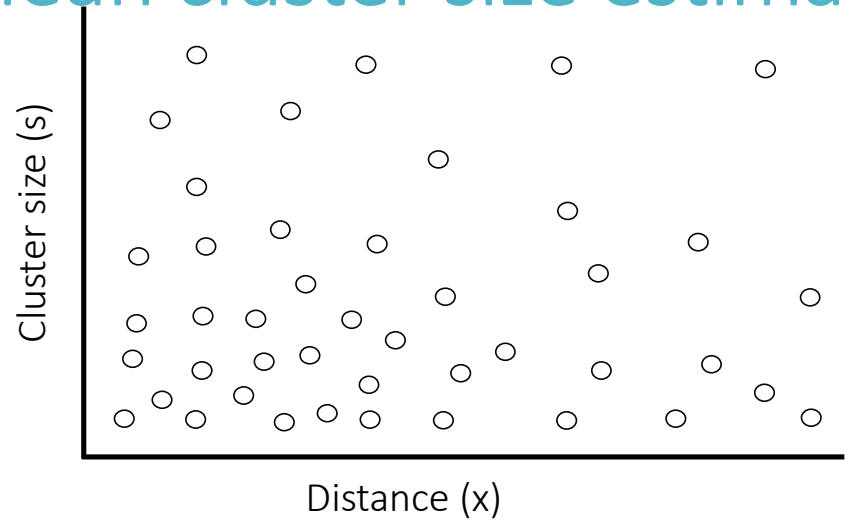
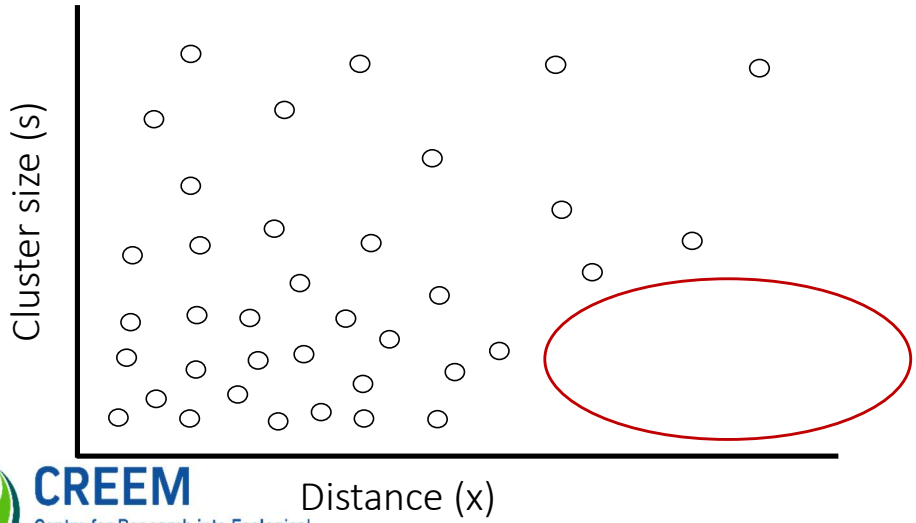
Mean cluster size estimation



No Size Bias

- Mean of observed sizes does not change with distance



Size Bias

- Smaller clusters less detectable at larger distances
- Mean observed cluster size **increases** with distance

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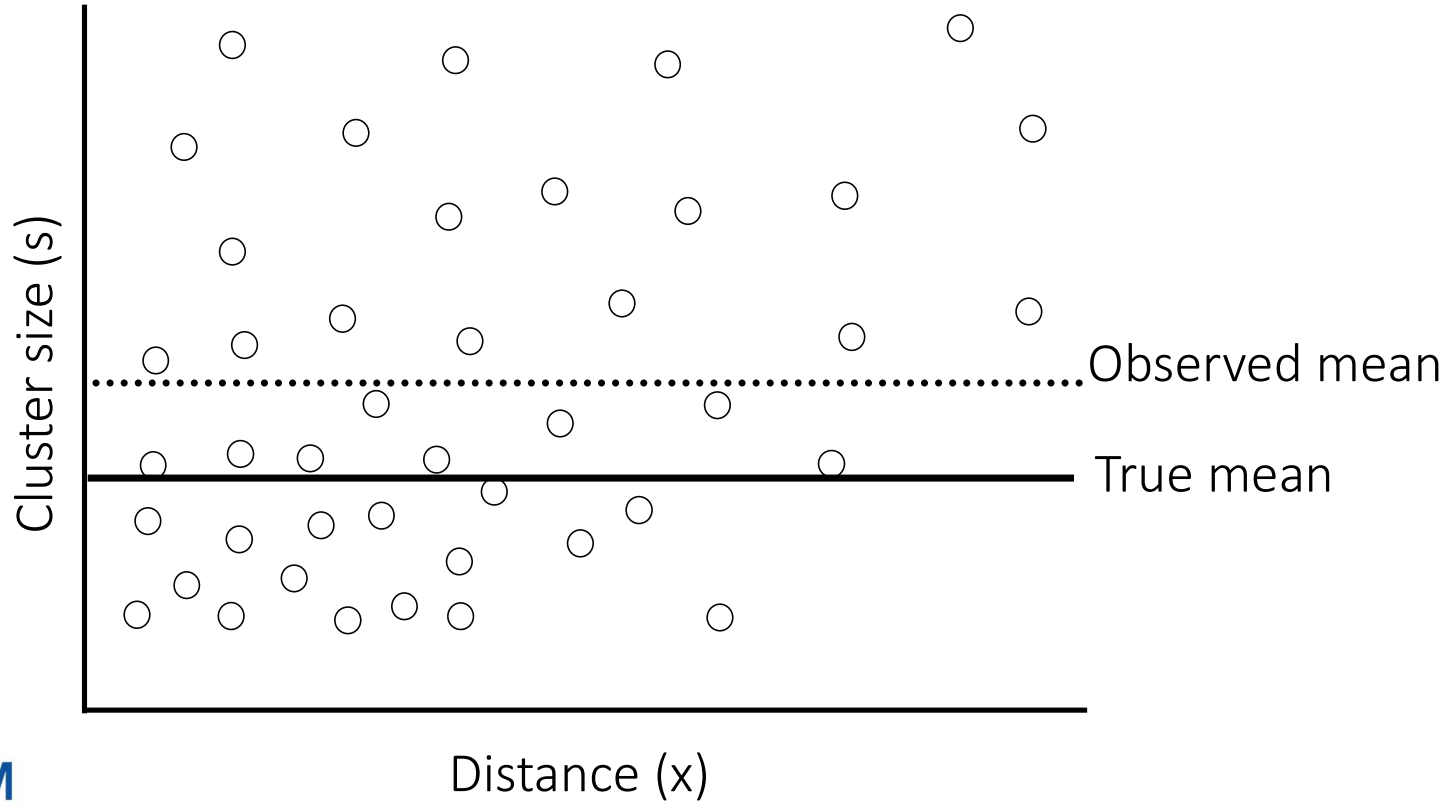
Effect of size bias on sample mean

If size bias is present, $\hat{E}(s) = \bar{s}$ will be positively biased:



Estimating $E(s)$ in the presence of size bias

- Regression methods
- Include size in model for detection function
- Stratify by cluster size
- Truncation of size-biased data
- Replace clusters by individuals

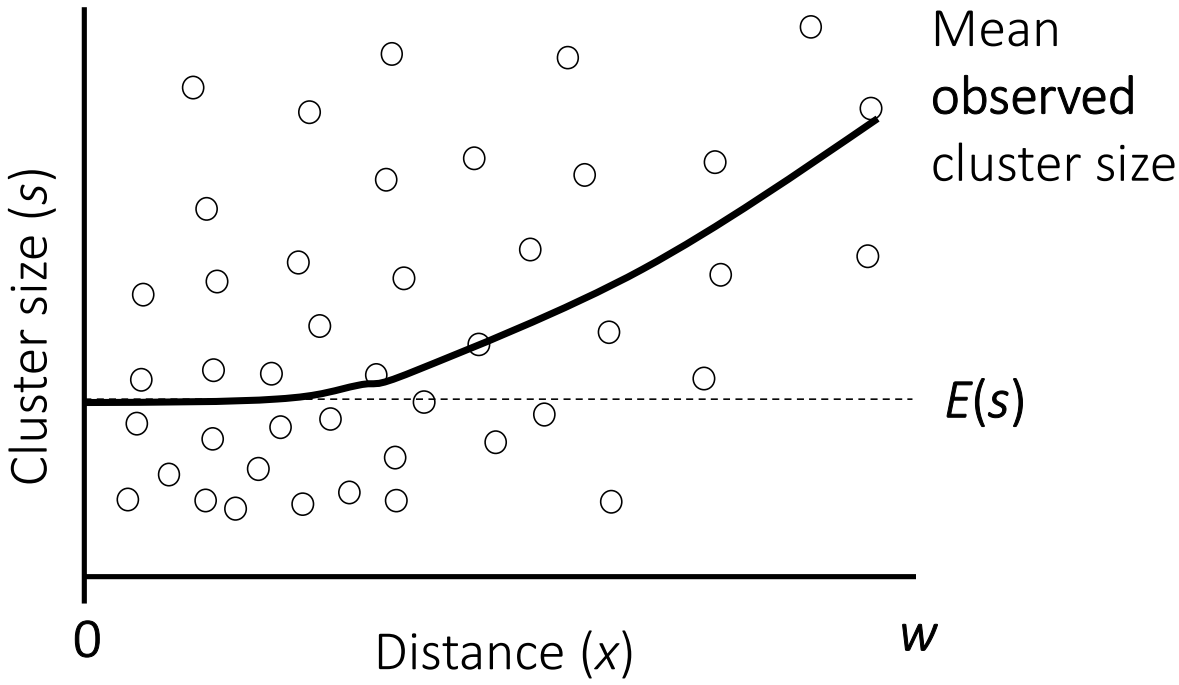
Regression methods: Default method in Distance for Windows

Include size in model for detection function: Multiple Covariate Distance Sampling

Stratify by cluster size, Truncation of size-biased data: Rarely used

Replace clusters by individuals: Applicable for “loose” clusters of individuals

Regression methods



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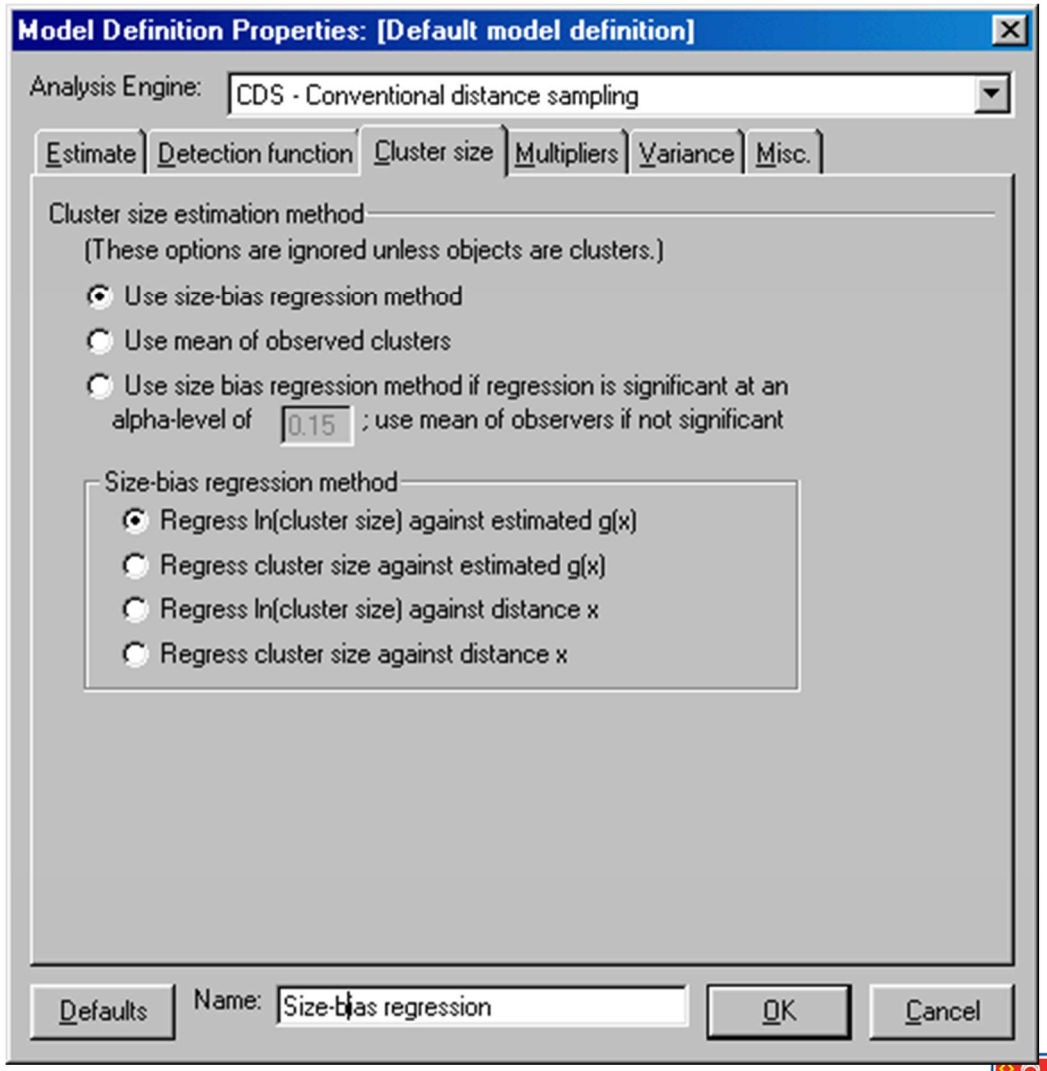
Problems with the linear regression method

- **Problem**: Relationship between *s* and *x* is not linear
  - no relationship when detection is certain (i.e. in the shoulder of the detection function)
- **Solution:** Linearize by regressing s on $\hat{g}(x)$

- **Problem**: Variance in *s* increases with *E*(*s*)
  - large cluster sizes distort the fit
- **Solution**: Regress **log of cluster size** on $\hat{g}(x)$

Estimating *E*(*s*) in Distance using regression methods



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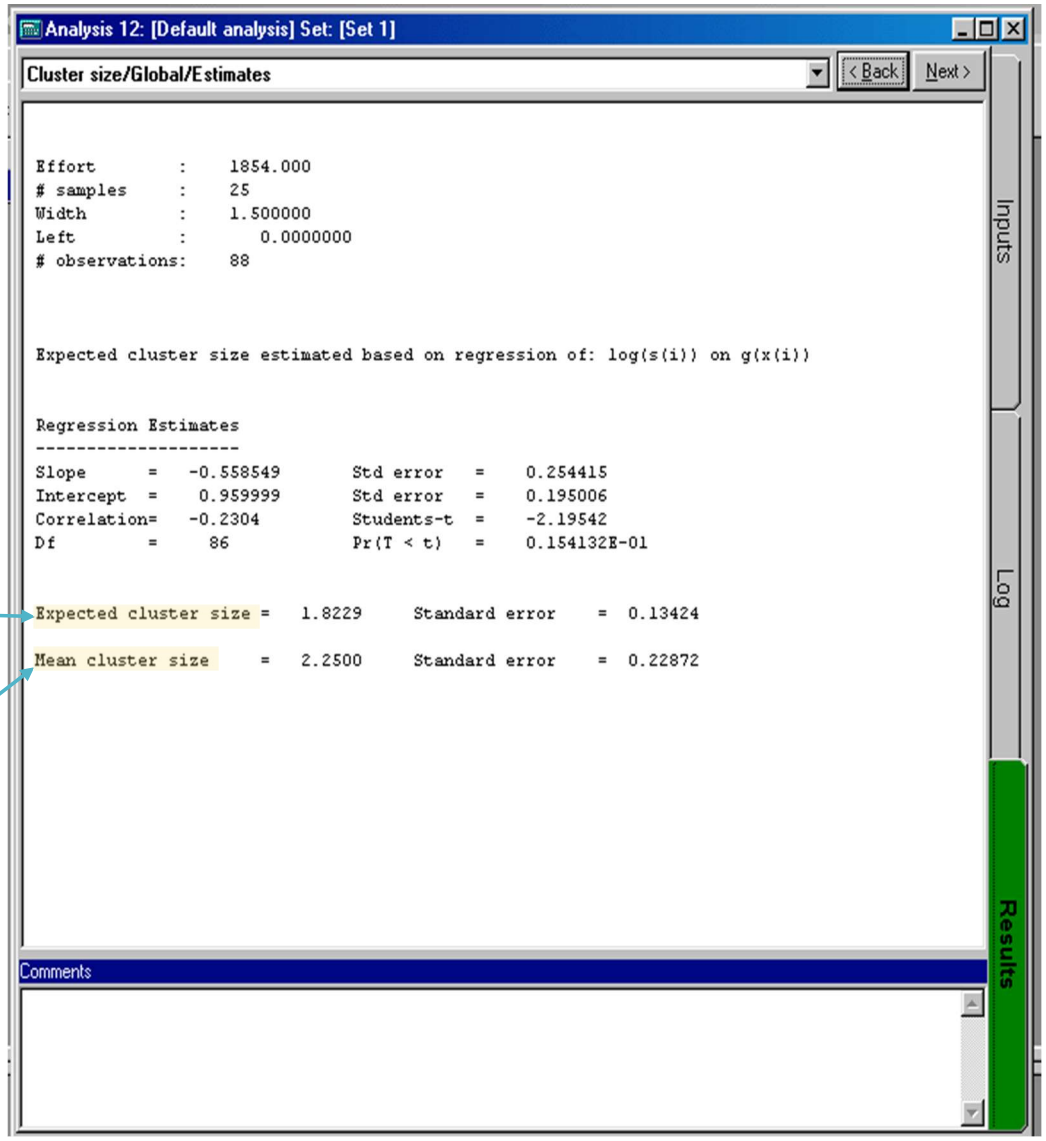
Output of regression estimates

Regression estimate of cluster size

Mean cluster size from data



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Data organisation and field issues

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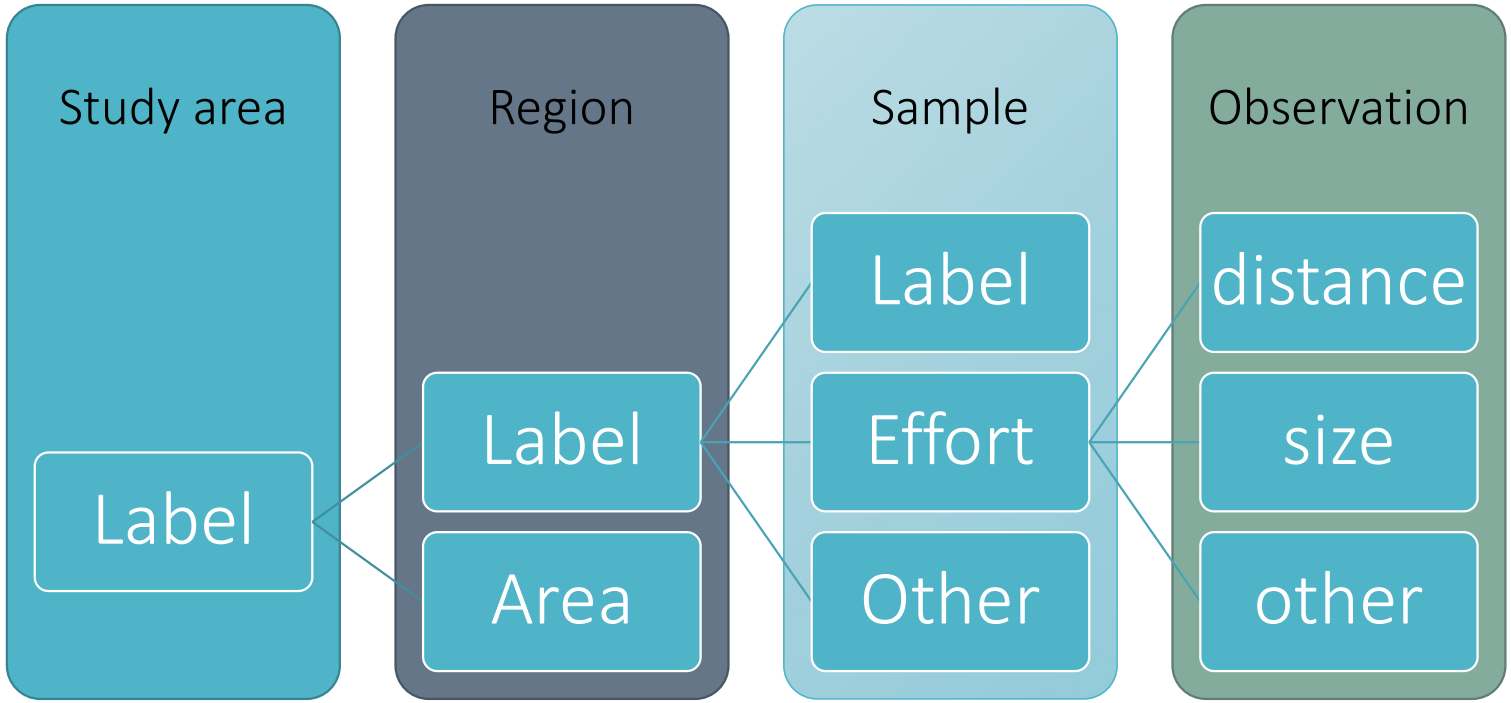
Data organisation hierarchy



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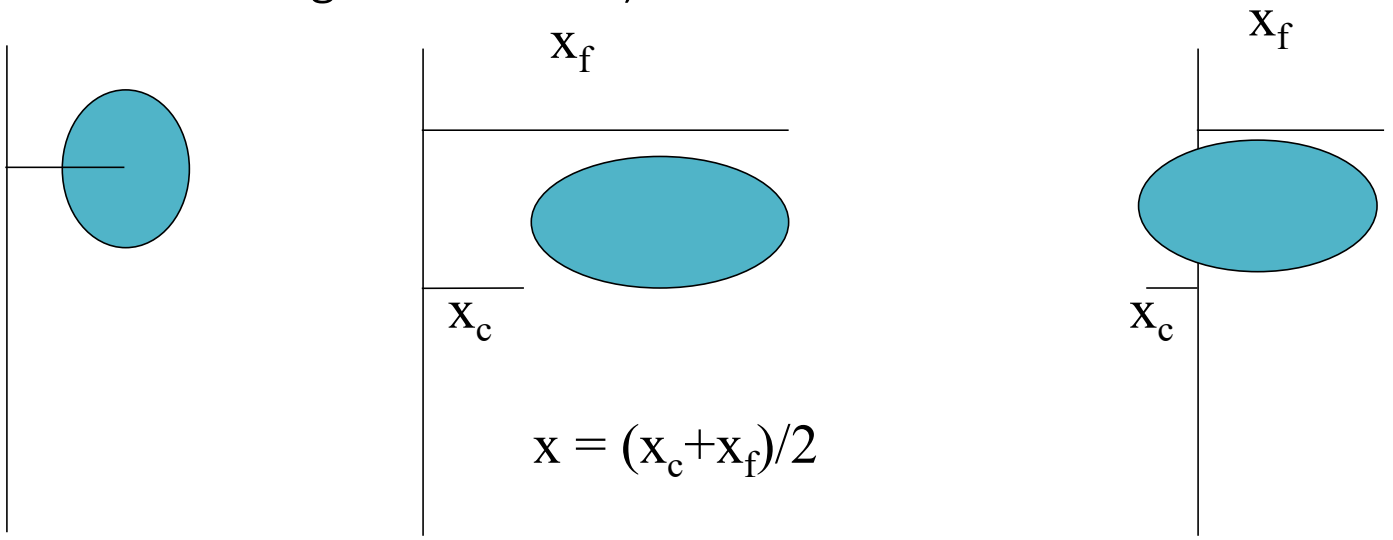
Get accurate and precise distances

- If size of animal/object is large compared to scale of measurements, define what measurement is to be made (e.g. from line to centre, tallest part, flower, etc)
- If measuring distances to clusters, get the distance to the “centre of the cluster”
- In practice, the mean between closest and furthest away distance might be enough (remember to collect signed distance)