Field Methods:
(given an adequate survey design has been used)

- Objectives of adequate field methods
  - g(0)=1
  - Reduce / avoid effect of movement
  - Get accurate and precise distances
- General recommendations
- A few special circumstances

References

- Chapter 7 of Buckland et al. (2001) Introduction to Distance Sampling
- Chapters 4, 10 and 12 of Buckland et al. (2015) Distance Sampling: Methods and Applications

> “Considerable potential exists for poor field procedures to ruin an otherwise good survey”

Goal: ensure key assumptions met

- $g(0)=1$
- no responsive movement prior to detection
- distances measured without error
- detection function has a wide shoulder

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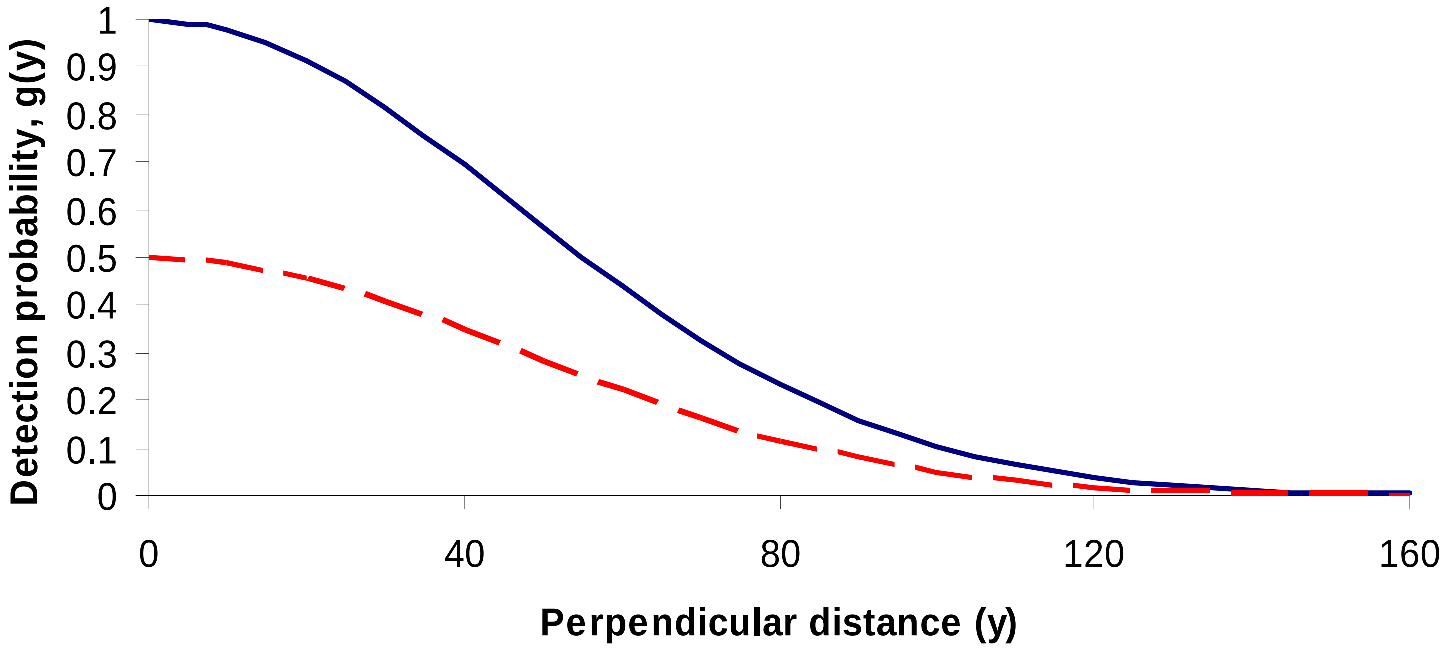
Make sure that g(0) is 1

Traditional data tells you nothing about g(0)

Good field methods and common sense help to achieve it



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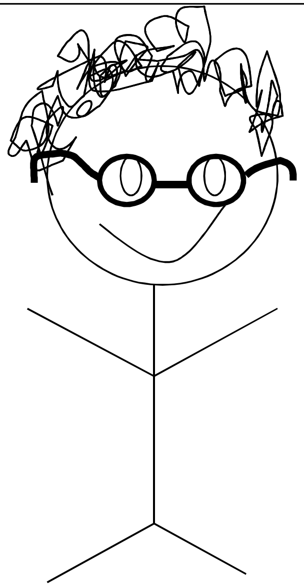
Make sure that g(0) is 1

- Do not try to see everything
- But try to see everything on the line
- *More detections do not necessarily equate to better data*

Wooden Stake Surveys N = 150



$$n = 55$$

$$\hat{N} = 138$$

$$n = 72$$

$$\hat{N} = 106$$

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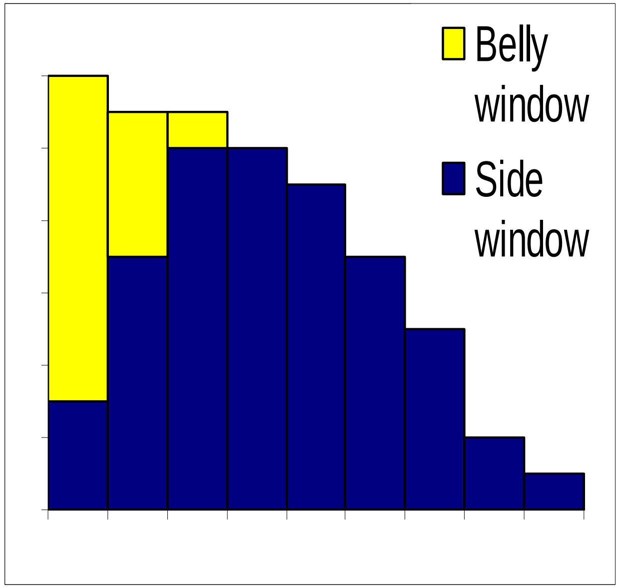
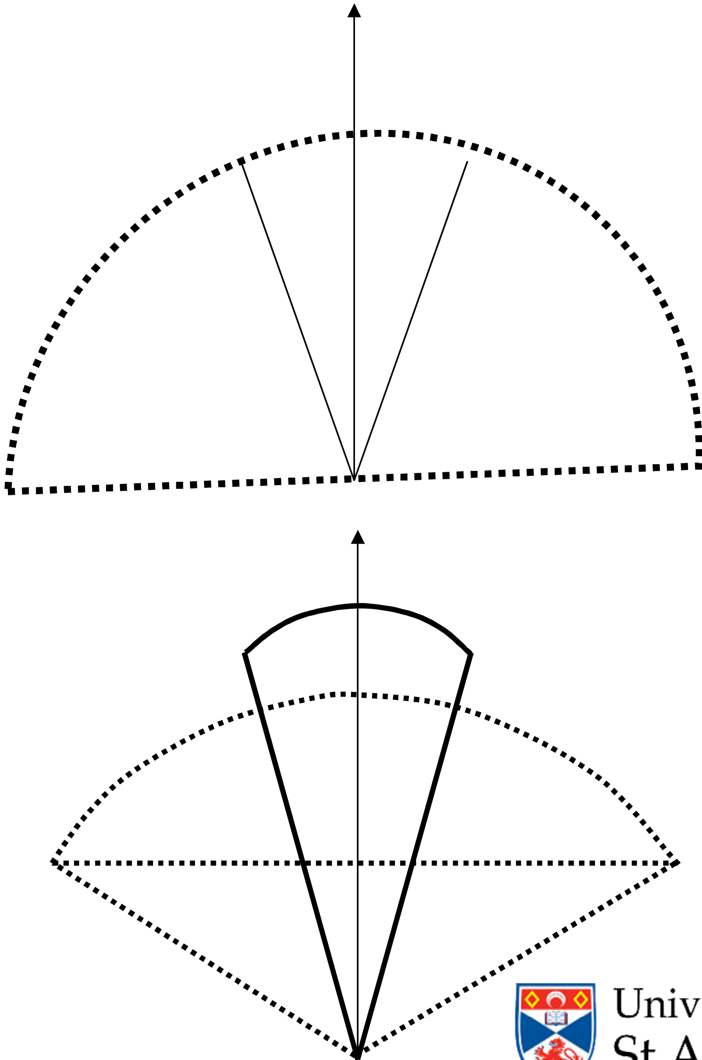
Make sure that g(0) is 1

- Use multiple observers
- But avoid spiked data...





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Warning – *g*(0) is probably < 1 !

Situation

Even with a well-defined search protocol and good observers, animals near the line may be missed

Problems

Underestimation in density/abundance

Added variability (if g(0) changes with survey period) reduces power

Solutions

Independent observers to estimate *g*(0)

Technology (Video Camera, Infrared)

Change methods (go slower, lower)

Independent estimates of g(0)

trials on animals of known location

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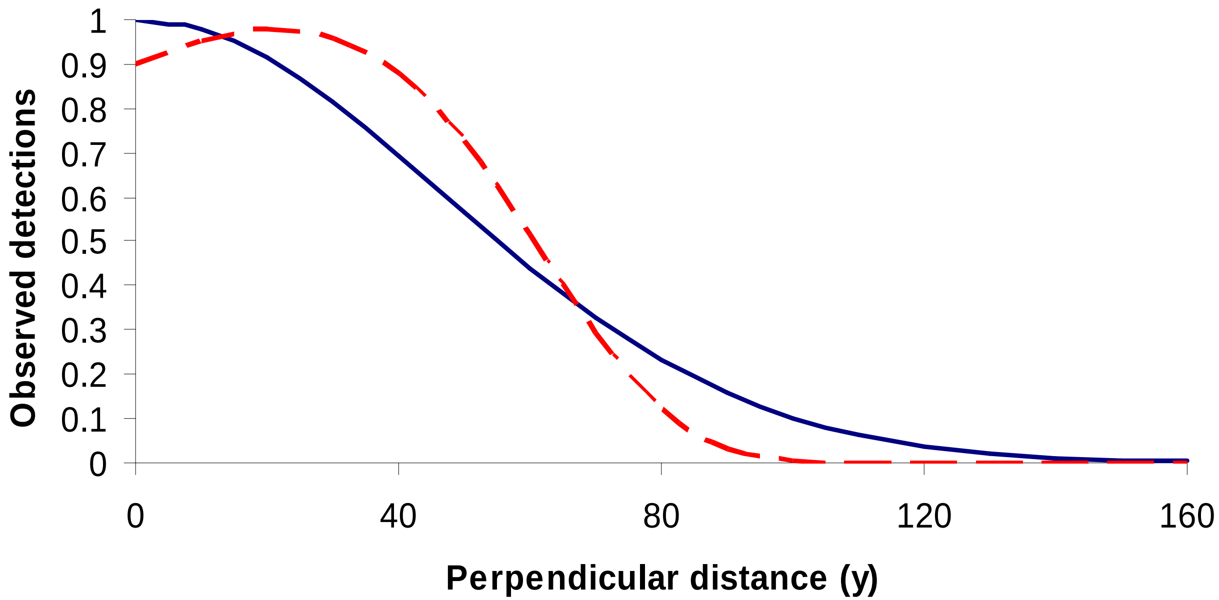
Avoid the effect of movement

detect animals prior to responsive movement



- effect on data is not always obvious

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Avoid the effect of movement

For points:

- Snapshot method, waiting periods (before and after)
- Use cues rather than individuals?

For lines:

- Look ahead
- Move slowly, carefully, quietly
- *but if observer speed < 2-3 times average animal speed, see Section 6.5 of introduction to distance sampling book*

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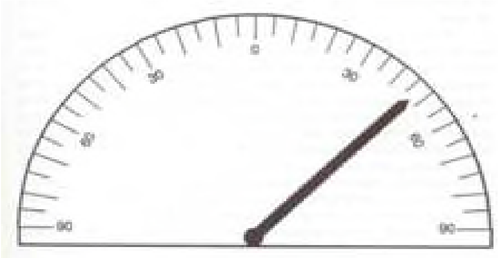
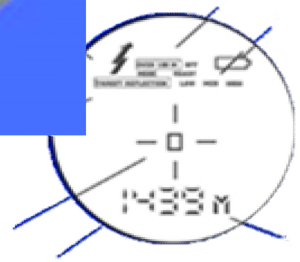
Get accurate and precise distances



Technological aids can be invaluable - use whenever possible

Avoid introducing more uncertainty by guessing



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Get accurate and precise distances

If possible, mark the transect line



A clear definition of what you are measuring distance to helps to guard against spiked data and bias

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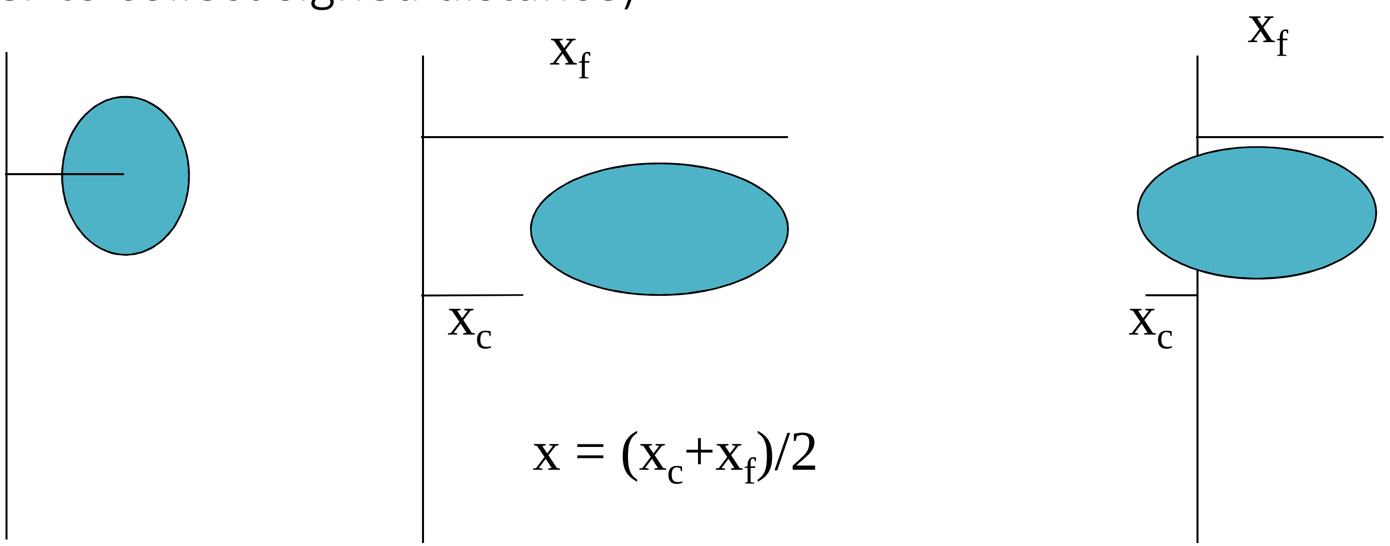
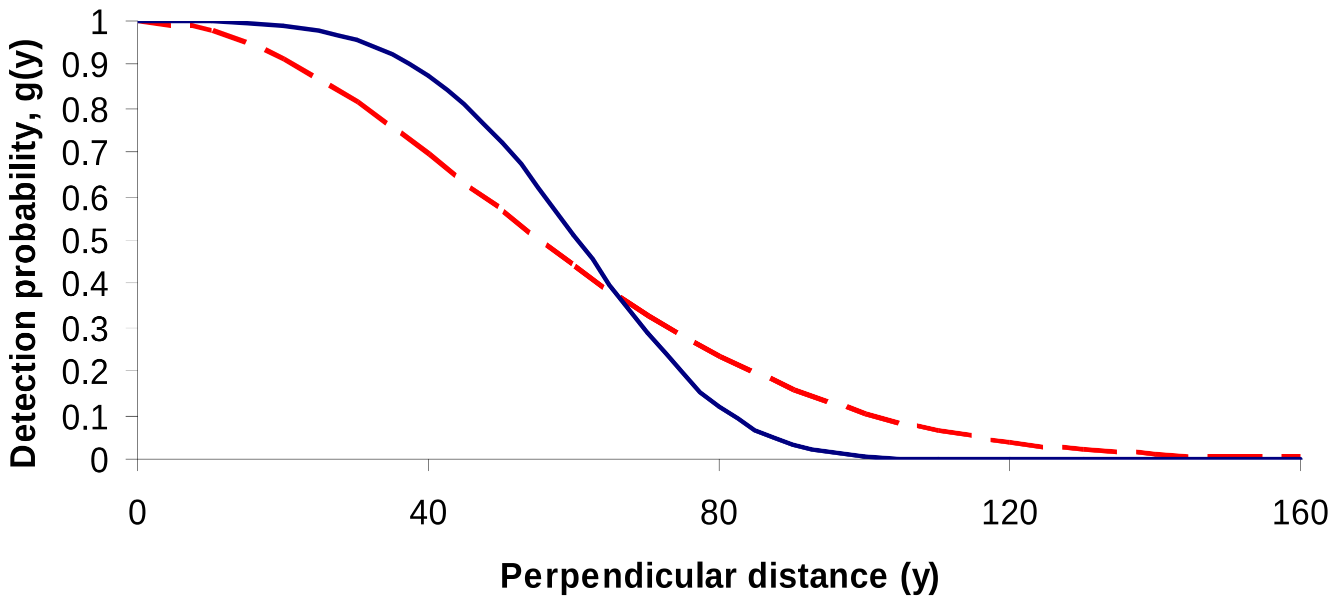
Get accurate and precise distances

- 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)



General recommendations

- Strive for wide shoulder in detection function



- Think about optimal effort allocation (ensure g(0) while distributing effort)
- More than one observer?

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General recommendations

- If possible, review data during survey

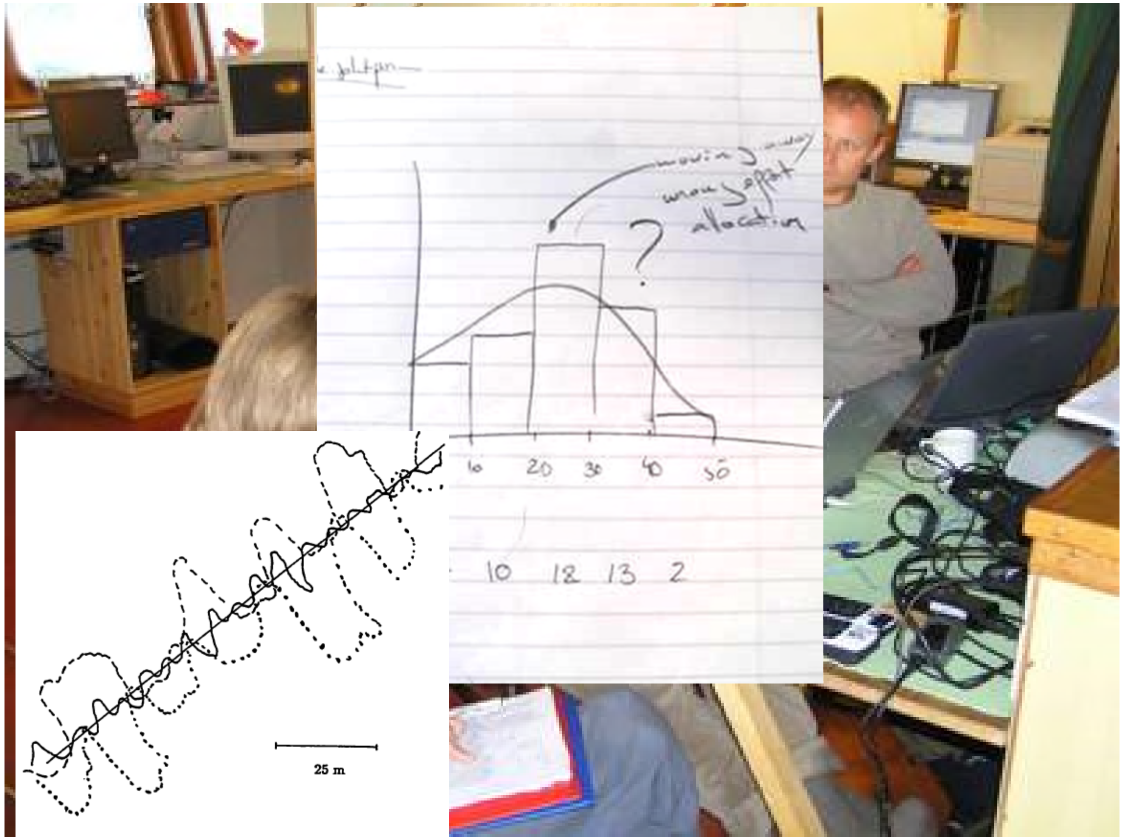


Fig. 6. Search strategy suggested by the distance data collected where a 3-person team is used to detect desert tortoise. This is only 1 part of the field protocol.

General recommendations

- Recording data should be easy, accurate and reliable

- Collect only relevant data
  - Perpendicular distance or distance and angle? (Angles for point transects?)
  - Cluster size
  - Effort (line length; no. of points); line or point ID

  - Observer name, survey block, date, start time, end time, weather, environmental conditions, habitat, sex, species, age, etc…

General recommendations

Make data collection as easy as possible e.g.:

- dedicated field sheets
- distance intervals for aerial surveys
- tape recorder + voice activated microphone
- separate person to record data
- automated data entry (ship’s GPS, etc.)
- video

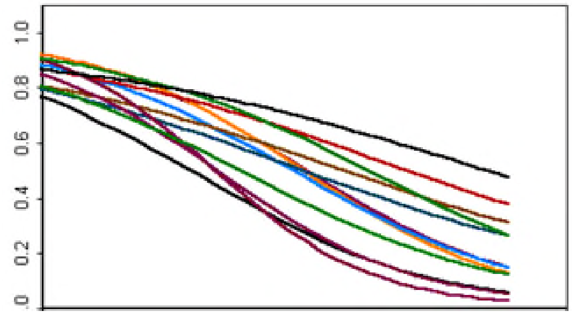
Have a backup

- backup recording method
- backup of field data

General recommendations

(most…) OBSERVERS ARE HUMAN…

- Observing for long hours can be boring – plan breaks /rotations
- Want to count what you see
- have a “>w” category
- for one-sided transects, have a category for negative values
- Teach observers how to search
- Emphasize effort on and near line
- Look ahead
- Look back if necessary
- Do not assume observers know what to do
- Go with observers to the field
- Test and train observers – reward good observers?



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Special circumstances: Multi-species surveys

Problems

- Species differences in detection
- Identification of similar species
- High density situations

Solutions

- Multiple observers
- Training
- Focus on key species

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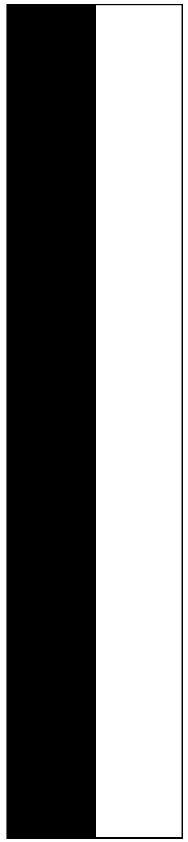
Animals at high density

- Consider strip transects
- Reduce truncation width
- Increase observation time (move more slowly)
- Multiple observers
- Streamline data collection

One-sided transects

- Avoid!
- Problems:
- *accurate line determination*
- *movement into or out of survey strip*
- Leads to heaping at zero distance



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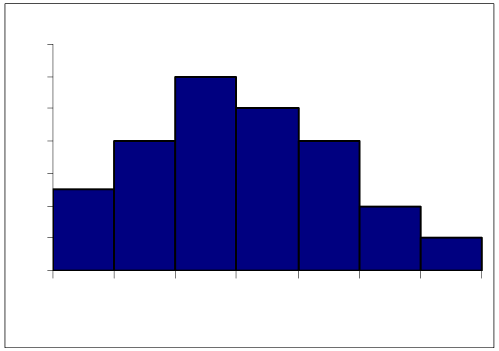
Some of what can go wrong, will likely go wrong

I spent all my money and have no data!

What do I do with this?



Situation

- Hi tech breakdown
- No planning
- Haven't thought about assumptions

Problems

- Data are lost
- Poor quality data

Solutions

- Sometimes low-tech is better
- Backups
- Conduct a pilot survey
- Train observers
- Examine data during survey

Which method when?

Strip transects

- Populations that occur in large, loose clusters (e.g. walruses)
- Stationary objects, at high density, and easily detected

Line transects

- Sparsely distributed populations for which sampling needs to be efficient (e.g. whales, deer)
- Populations that occur in well-defined clusters, and at low or medium cluster density (e.g. dolphin or fish schools)
- Populations that are detected through a flushing response (e.g. grouse, hares)

Point transects

- Populations at high density, especially if surveys are multi-species (e.g. songbirds)
- Populations that occur in patchy habitat
- Populations that occur in difficult terrain, or on land where access to walk predetermined lines is problematic (e.g. bird populations in rain forest or on arable farmland)

Sample size

Estimating the required sample size when designing a distance sampling survey.

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Sample size

- Aim for at least 60-80 sightings for fitting the detection function
- and at least 20 lines or points for estimating encounter rate n/L or n/k
- Whether reliable estimates can be obtained from smaller samples depends on the data

Sample size – continued

More observations are required:

- if detection function is spiked
- if population is highly aggregated
- for point transect sampling

Increasing sample size using repeat counts

If a line is sampled three times,

- pool the distance data from the three visits
- enter survey effort as three times the line length.

If a point is sampled three times,

- enter survey effort as 3.

Determining total line length

Pilot study: n_0 animals (or clusters) counted from lines totalling L_0 in length.

Total line length required in main survey is

$$L = \left(\frac{q}{\left[cv_t\left(\hat{D}\right) \right]^2} \right) \times \frac{L_0}{n_0}$$

Where $cv_t\left(\hat{D}\right)$ is the target cv (e.g. 10% is 0.1) and...

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Determining line length (cont)

q is approximately $$\frac{V(n)}{n} + \frac{nV[\hat{f}(0)]}{[\hat{f}(0)]^2}$$

Pilot studies are typically too small to estimate q. If past similar data sets are not available, assume $q = 3$.

Line length example

A pilot study yields n_0 = 20 observations from lines of total length 5km. We require a CV of 10%, and assume q = 3.

$$L = \frac{3}{0.1^2} \times \frac{5}{20} = 75\text{km}$$

Estimated sample size is

$$n = L \times \frac{n_0}{L_0} = 75 \times \frac{20}{5} = 300$$

Determining line length (cont)

If pilot survey is sufficiently large, calculate line length for main survey as

$$L = \frac{L_0[cv(\hat{D}_0)]^2}{[cv_t(\hat{D})]^2}$$

where

$cv(\hat{D}_0)$ is the cv of estimated density obtained from the pilot survey, and L is total line length in the main survey

Point transects: number of points

or

$$k = \left(\frac{q}{[cv_t(\hat{D})]^2} \right) \times \frac{k_0}{n_0}$$

$$k = \frac{k_0 [cv(\hat{D}_0)]^2}{[cv_t(\hat{D})]^2}$$

where k_0 points in the pilot survey yielded n_0 detections, or estimated density of $\hat{D}_0$

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Checklist for a good survey

- Is distance sampling appropriate for your study; if so which variation?
  - Do study animals occur at high density?
  - Is terrain difficult to traverse or is estimation of distances difficult because it is being done by calls?
  - Do animals exhibit responsive movement?
    - *Do animals move much faster than observers?*
    - *Are animal densities so low that sufficient detections is impractical?*
- How do animals distribute themselves?
  - Is there an animal gradient across study area?
  - Do animals exhibit habitat preferences?
    - *Are preferred habitats in distinct patches or gradually changing habitat?*
  - Small-scale animal gradients with respect to the transects?
  - Does the study organism travel in groups?

Checklist continued

- Other potential assumption failures
  - Imperfect detection on the transect
  - Measurement error in detection distances
- Final points to consider
  - Are you considering use of roads or tracks?
  - Will randomisation be used to locate samplers within the study area?
  - What was learned from the pilot study?

Analysis Hints

Taken (largely) from:

- Section 2.5 of Buckland et al. (2001) Introduction to Distance Sampling
- Thomas et al. (2010) Distance software: design and analysis of distance sampling surveys for estimating population size. Journal of Applied Ecology 47:5-14.

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Analysis hints

This is not a cookbook!

Do not simply use the function defaults in Distance!

The art of model selection

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Analysis hints

Stage 1: Exploratory data analysis

- Goal is to understand patterns in distance data, and make preliminary decisions about analysis
- It is never too early to start looking at the data (can then rectify problems)
- Exact data: examine QQ-plots and histograms with lots of cut points (in `plot` function use arguments `nc` (number of equal-width bins) or `breaks` (user-defined break points)
- Carry out preliminary analysis with a simple model (e.g. half normal, no adjustments). Examine histograms to assess if assumptions are violated
- Make preliminary decisions about truncation and whether to group exact data (to bin data use argument `cutpoints` in `ds` function)
- For clustered populations, look for evidence of size bias

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Analysis hints

Stage 2: Model selection

- Decide whether to analyse the data as grouped or ungrouped
- Select appropriate truncation distance.
- Choose cutpoints if using grouped data.
- Select and fit a small number of key/adjustment combinations
- Check histograms, goodness-of-fit, AIC and summary tables and choose a model
- This is an iterative process – more exploratory work may be required.
- Check evidence of size-bias if population is in clusters

Analysis hints

Stage 3: Final analysis and inference

- Select best model, or
- Perhaps use model averaging - bootstrap with more than one model selected if model choice is uncertain and influential
- Extract summary analyses and histograms for reporting