

# 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”

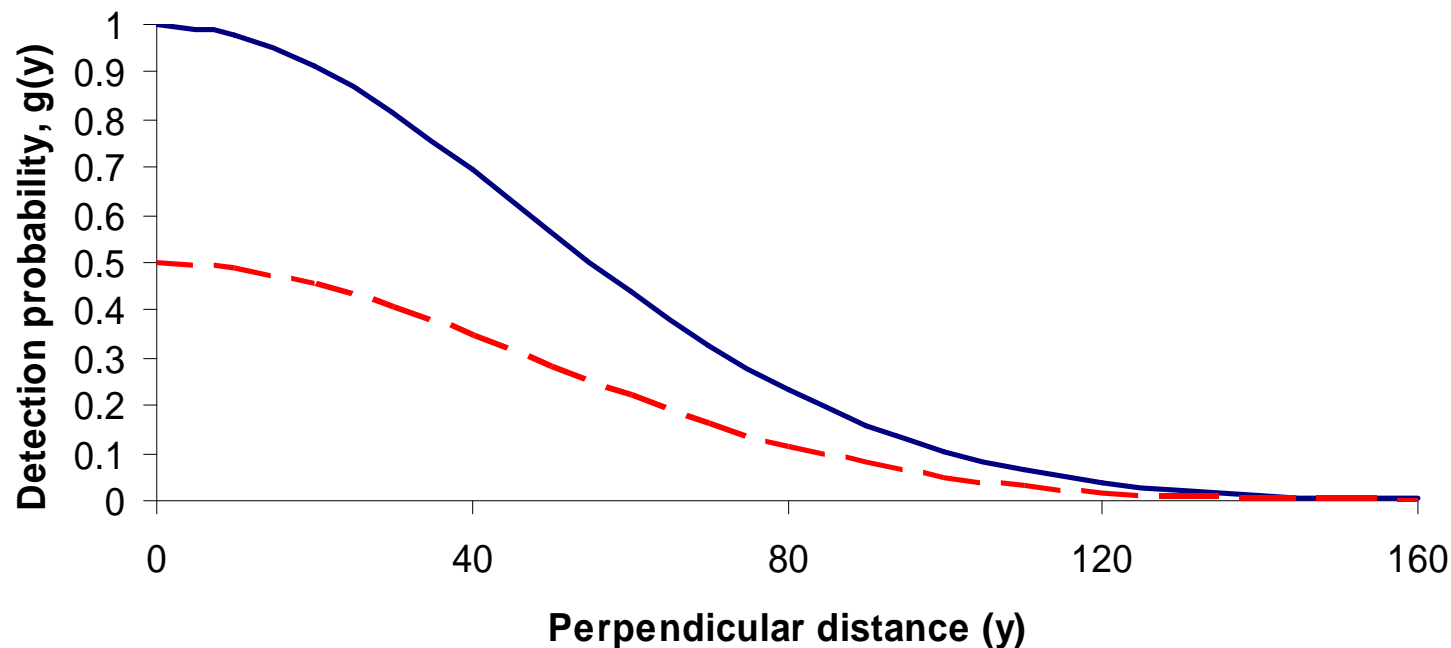
Goal: ensure key assumptions met

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

# Make sure that $g(0)$ is 1

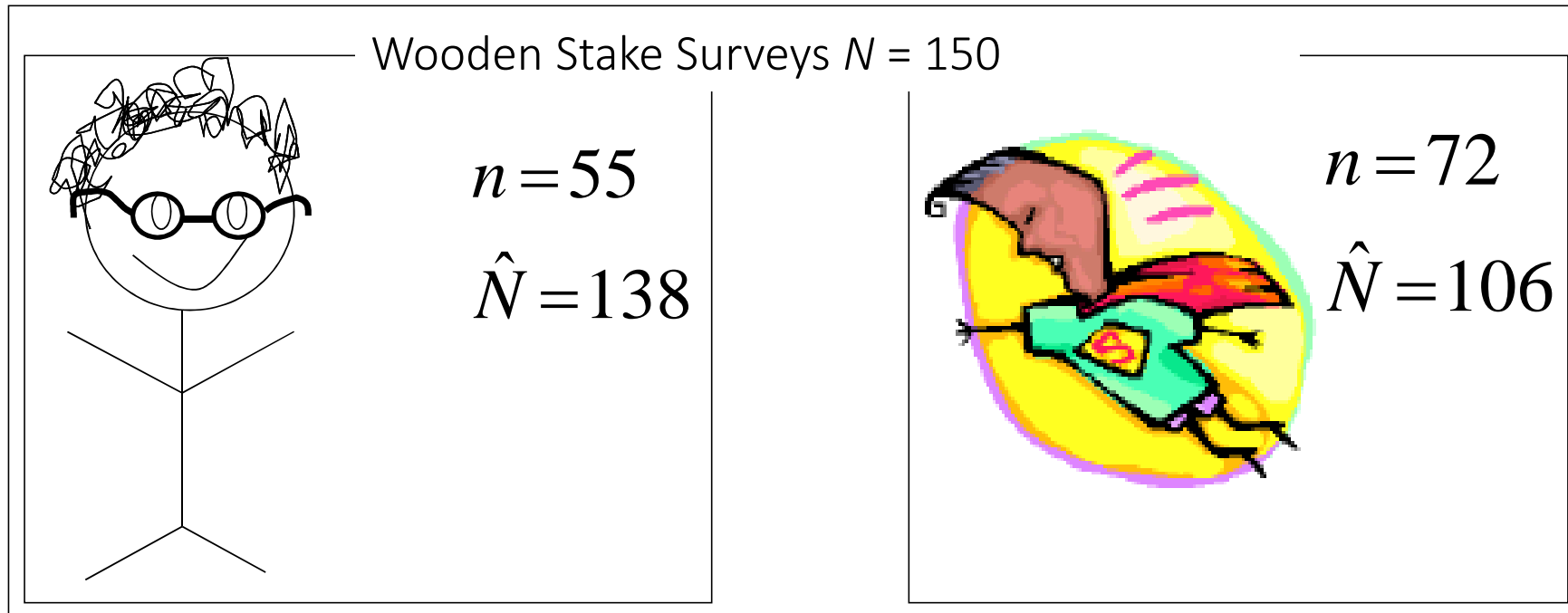
Traditional data tells you nothing about  $g(0)$

Good field methods and common sense help to achieve it



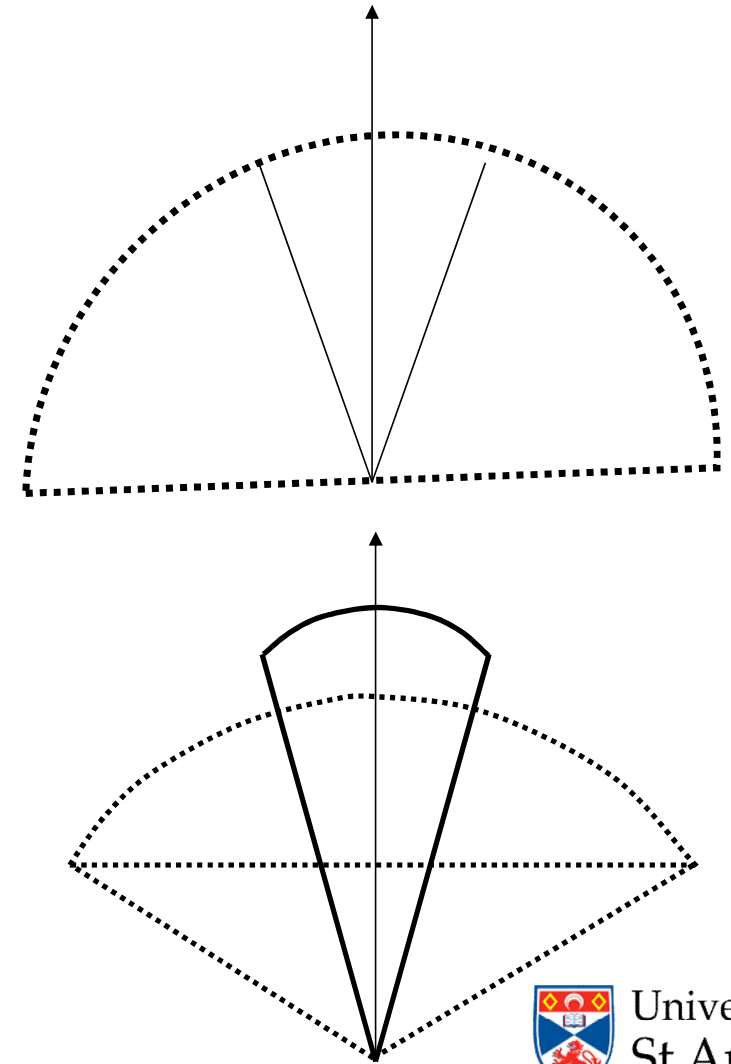
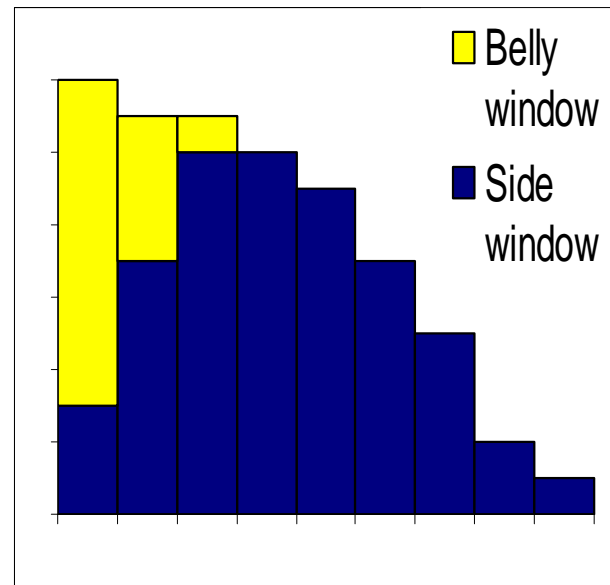
## Make sure that $g(0)$ is 1

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



# Make sure that $g(0)$ is 1

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



# 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)

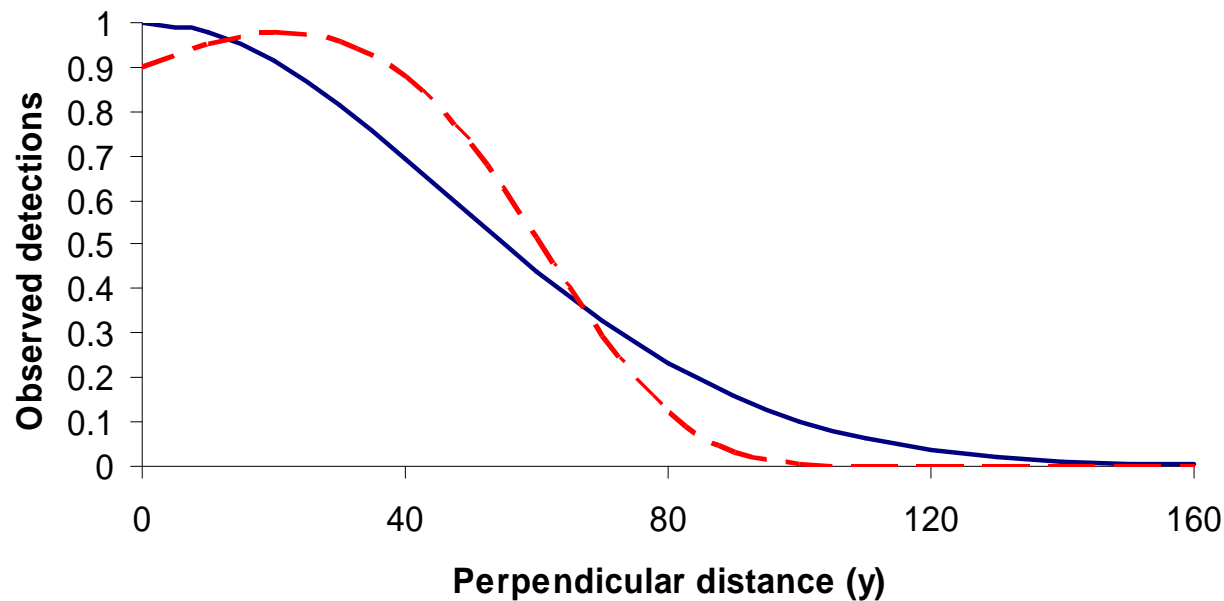
Independent estimates of  $g(0)$

trials on animals of known location



# Avoid the effect of movement

detect animals prior to responsive movement



- effect on data is not always obvious

# Avoid the effect of movement

For points:

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

For lines:

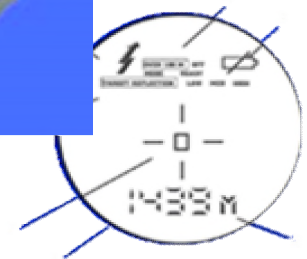
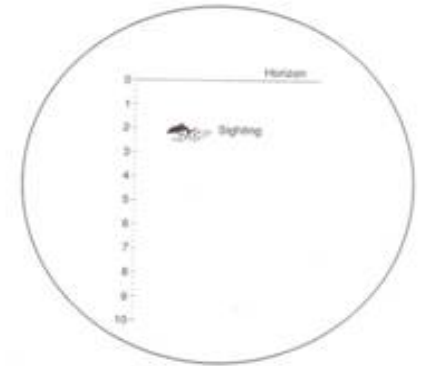
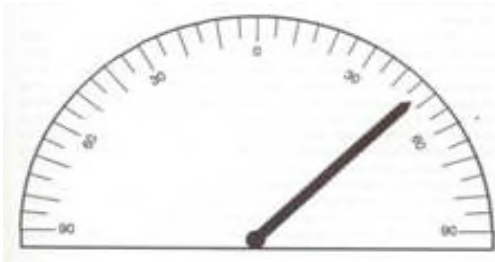
- Look ahead
- Move slowly, carefully, quietly
- *but if observer speed < 2-3 times average animal speed, see Section 6.5 of introduction to distance sampling book*



# Get accurate and precise distances

Technological aids can be invaluable - use whenever possible

Avoid introducing more uncertainty by guessing



# Get accurate and precise distances

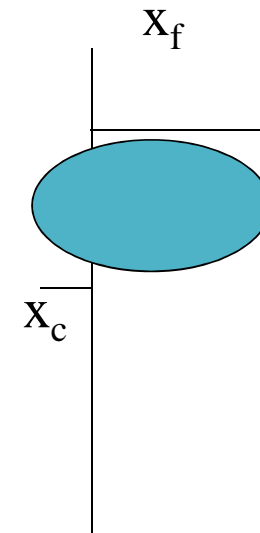
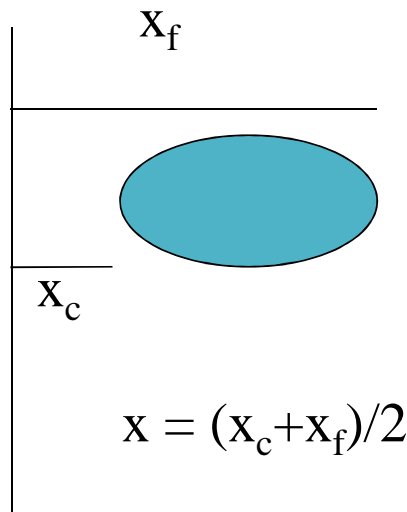
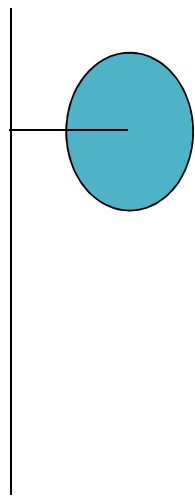
If possible, mark the transect line



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

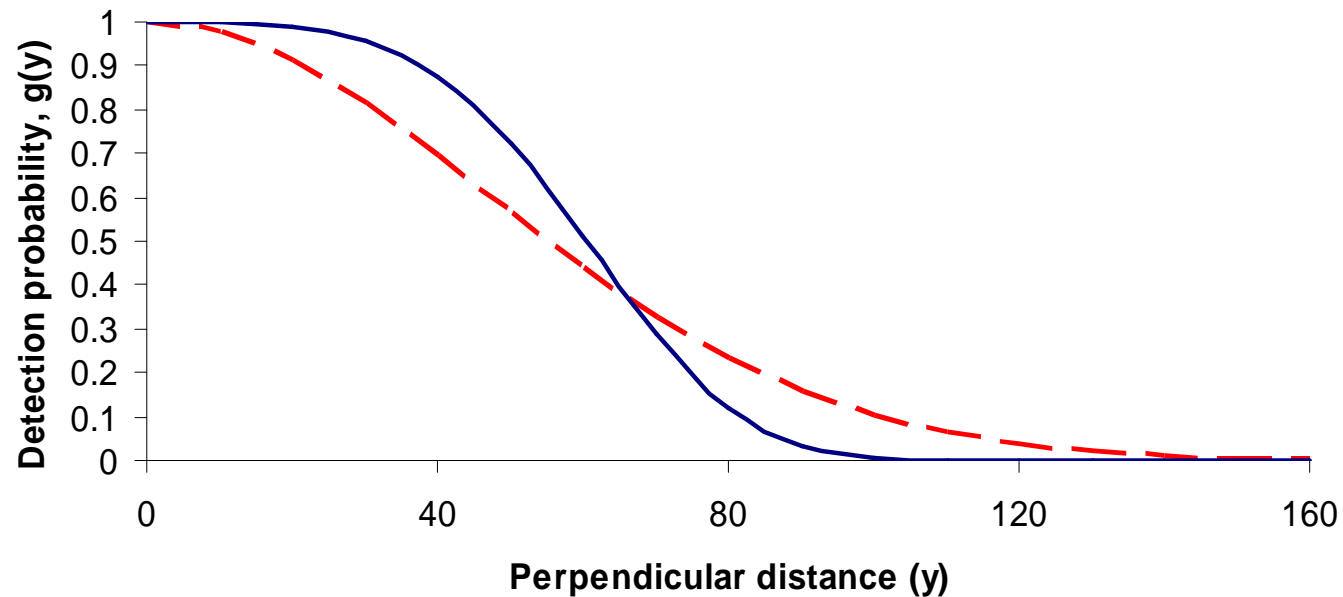
# Get accurate and precise distances

- 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?

# General recommendations

- If possible, review data during survey

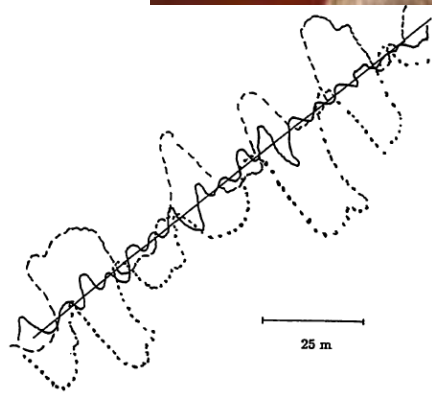


Fig. 6. Search strategy suggested by the distance data collected where a 3-person team is used to detect desert tortoise. This is only 1 part of the field protocol.

# 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

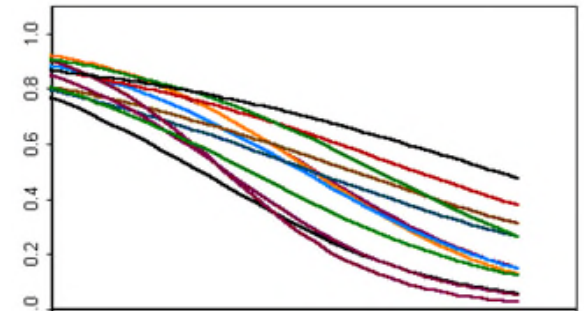
Have a backup

- 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?





# 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



# 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

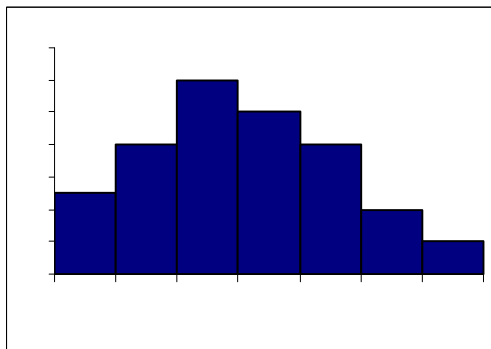


# Some of what can go wrong, will likely go wrong

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)

# 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.



# Analysis hints

This is not a cookbook!

Do not simply use the function defaults in Distance!



The art of model selection

# 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 (see later lecture).

# 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