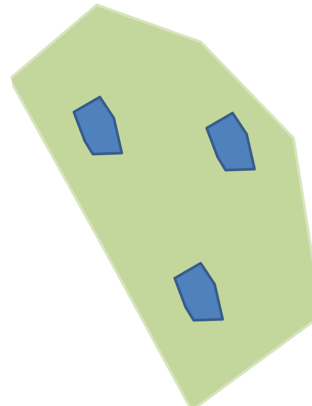
Methods for estimating abundance

Naïve counts do not account for probability of detection in different seasons, habitats, or methods

Population estimates that we will focus on next, and that you will use most often do.

There are many variations but all are summarized by:

Estimate of abundance =
Count of animals/probability of detection



- Total Counts on sample plot
  - Survey smaller area, *B = proportion of total area sampled*
  - $N = c / B * p$

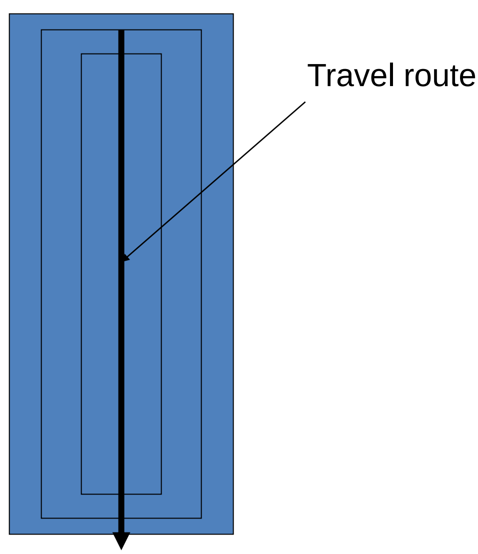
  c = count, N = abundance estimate, p = prob detection

Line Transects

Move along travel route and estimate perpendicular horizontal distance between you and animal/group.

Distance estimation requires training of field crews and frequent retraining.

Software available for calculating density (DISTANCE) based on effective detection distances.



Some Transect Methods for Estimating Abundance/density

•Simple

•Double Sampling:
- •incomplete counts over large area (i.e. aerial)
- •Complete/extensive census on smaller area/subset of transects
- •Detection probability =
  large (aerial) count/ mn extensive count

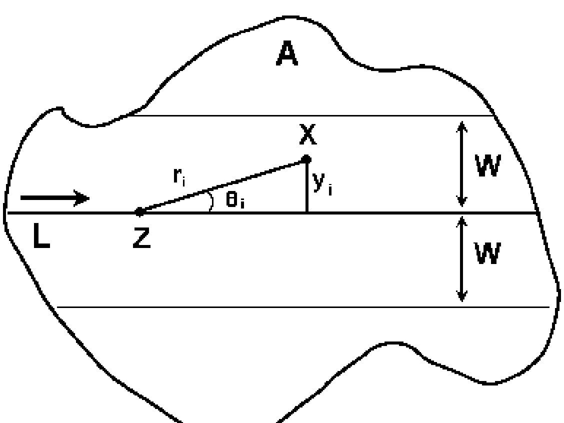
•Multiple Observers:
- • multiple observers count separately but close enough in time to count mostly same animals
- •Detection probabilities based on overlap

•Distance sampling

•Sightability Models

Distance Estimation of Abundance:

Assumptions and Possible Sources of Bias



General Approach/Assumptions

- Density is homogeneous within the survey area
- Some individuals go undetected
- Probability of detection is related to distance from the observer
- If we can assume all individuals at distance = 0 are detected, we can estimate the proportion that go undetected
- Points are fixed at the initial sighting position (i.e., no movement before or after).
- Distance and angles are measured exactly.
- Sightings are independent events.
- For clustered populations, the probability of sighting a cluster (e.g., flock, covey, etc.) is independent of cluster size.

Point Counts

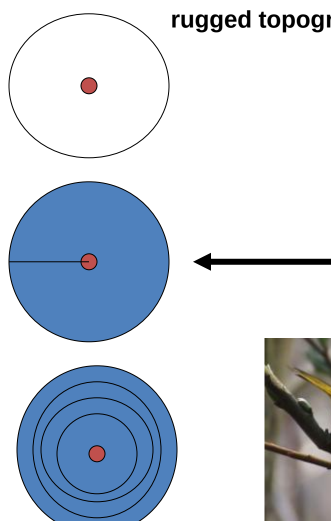
The preferred method to survey birds in forests, especially in rugged topography.

Types:

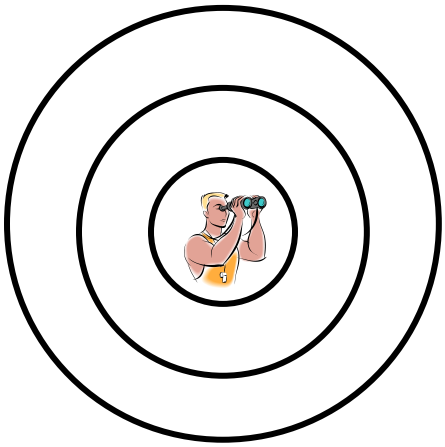
Simple

Fixed-radius

Variable radius

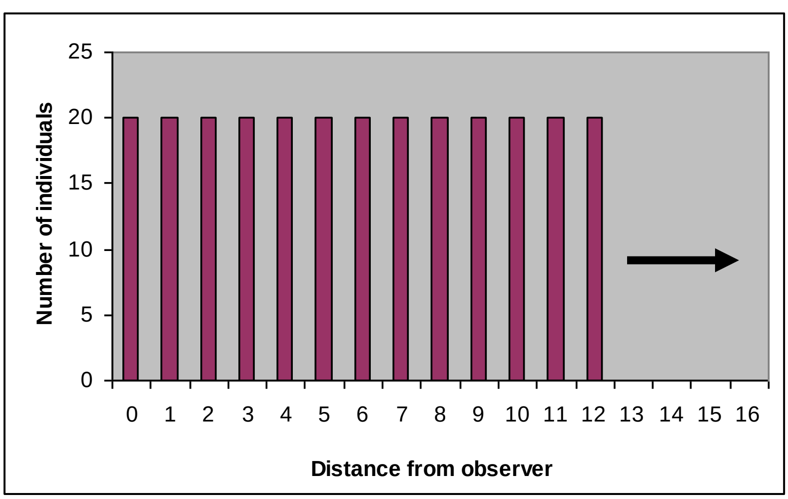


Distance Sampling: Point Counts

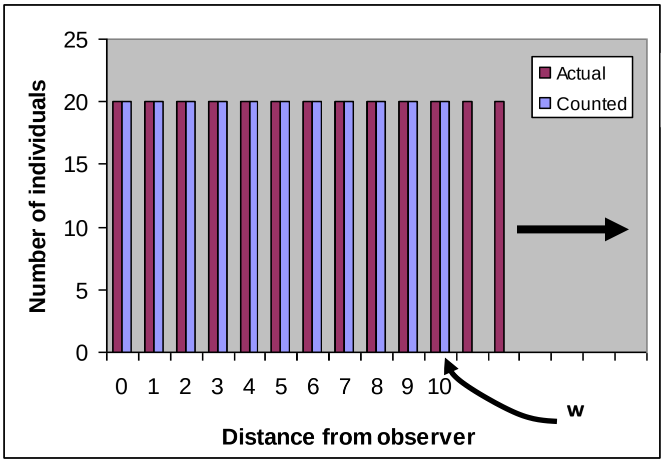


- Homogeneous density
  - Number in each ring increases due to increased area
  - *Density* is the same in each ring

Distance Sampling: Line Transects



Density Estimation:
Perfect Detection



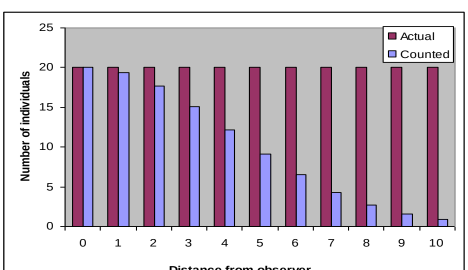
Line transect:

$$Abund = \frac{\#Counted}{2wL}$$

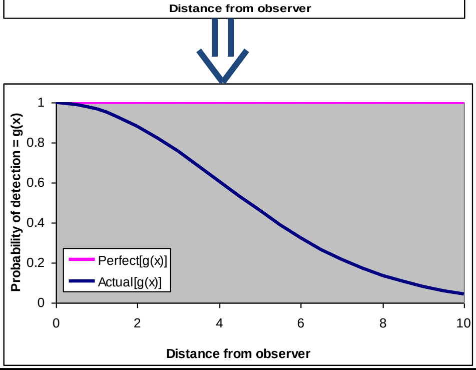
Point count:

$$Abund = \frac{\#Counted}{\pi w^2}$$

Abundance Estimation: Imperfect Detection



$$Abund = \frac{\#Counted}{ProportionDetected(PD)}$$

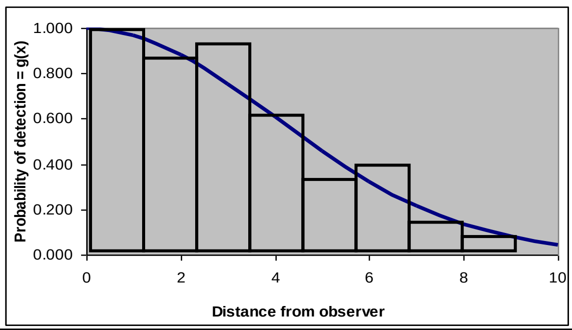


$$PD = \frac{\int_0^w Actual[g(x)]}{\int_0^w Perfect[g(x)]}$$

Abundance Estimation: Imperfect Detection

IF *Actual*[*g*(*0*)] = 1

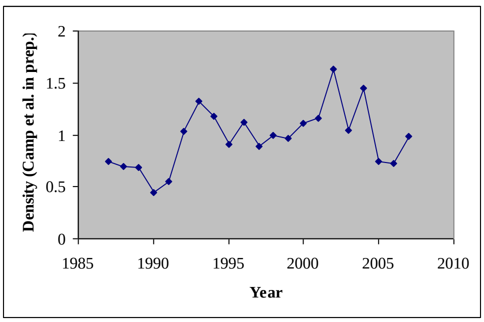
$$PD = \frac{\int_0^w Actual[g(x)] = fitted}{\int_0^w Perfect[g(x)] = 1 \times w}$$



Effects of Behavioral Changes

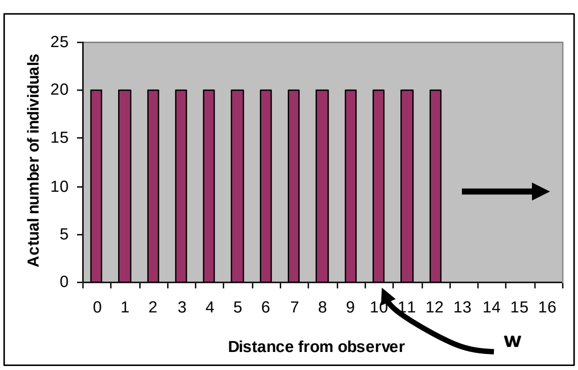
- What if proportion detected changes from year to year?
- Under what conditions will estimates be biased?
- How does the assumption that *Actual*[*g*(*0*)] = 1 fit in?

Hawaiian Akepa



- Freed et al. suggested increased detectability of stressed individuals
- Could bias high recent estimates of density

Assumptions for Detectability Scenarios

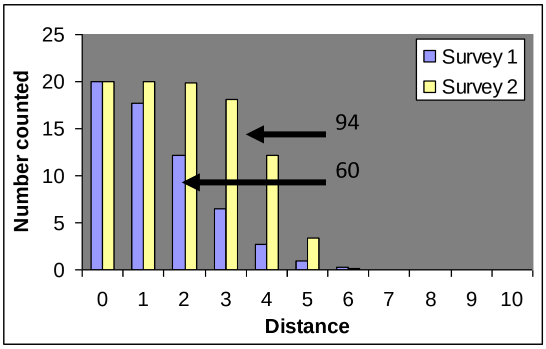


Line transect

$$Abund = \frac{\#Counted}{2wL}$$

- *Abund* = 20 * 11 = 220
- No change in true abundance between 2 surveys

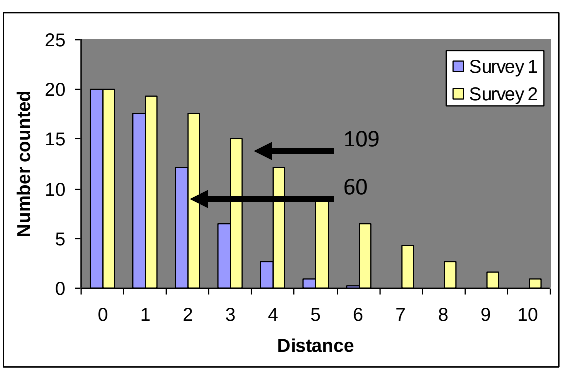
Scenario 1



- Increased detection
  - more singing/calling
- Result
  - more detections within a maximum distance

	# counted	*g(0)*	*PD*	*Abund*
Survey 1	60	1	0.27	220
Survey 2	94	1	0.43	220

Scenario 2

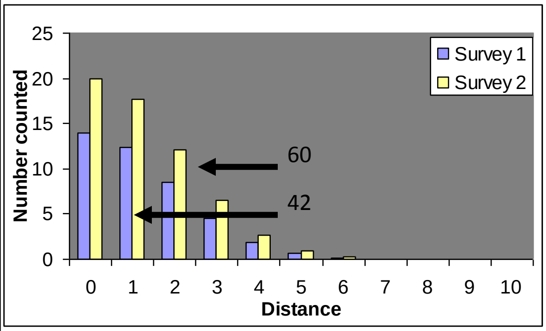


Increased detection
- more movement
- more singing

Result
- more detections at further distances

	# counted	*g(0)*	*PD*	*Abund*
Survey 1	60	1	0.27	220
Survey 2	109	1	0.50	220

Scenario 3



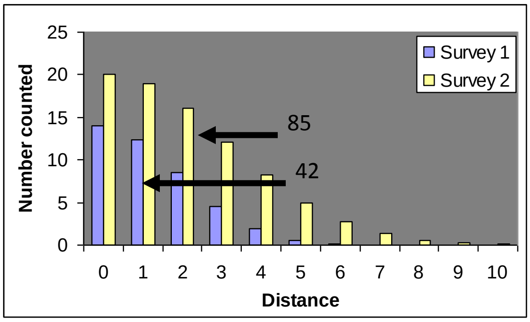
- Increased detection
  - more singing/calling
- Result
  - more detections within a maximum distance
  - increased detection at distance = 0

Results Scenario 3

Assumed	# counted	*g(0)*	*PD*	*Abund*
Survey 1	42	1	0.27	154
Survey 2	60	1	0.27	220

Actual	# counted	*g(0)*	*PD*	*Abund*
Survey 1	42	0.7	0.19	220
Survey 2	60	1	0.27	220

Scenario 4



- Increased detection
  - more singing/calling
  - more movement
- Result
  - more detections
  - increased detection at distance = 0

Results Scenario 4

Assumed	# counted	*g(0)*	*PD*	*Abund*
Survey 1	42	1	0.27	154
Survey 2	85	1	0.39	220

Actual	# counted	*g(0)*	*PD*	*Abund*
Survey 1	42	0.7	0.19	220
Survey 2	85	1	0.39	220

Results Summary

- Estimates are unbiased due to increased detectability IF *Actual*[*g*(*0*)] = 1 for both surveys
- Estimates are biased low IF *Actual*[*g*(*0*)] < 1

What Does This Mean for Trend Analysis

- IF
  - If probability-of-detection at close distances is constant through time… — Valid index
  - If varies but around a constant 'mean'… — Valid index
  - If there is a systematic bias over time… — Invalidates trend analyses and must be accounted for

Correcting the Bias

- There is a relationship between the true number and the *biased* estimate IF *Actual*[*g*(*0*)] is KNOWN

$$TrueAbund = EstAbund * 1/ Actual[g(0)]$$

Estimating *Actual*[*g*(*0*)]

- Paired observer methods (Kissling and Garton 2006)
- Model the probability of detection at close distances based on environmental covariates

Kissling, M. L. and E. O. Garton. 2006. Estimating detection probability and density From point-count surveys: a combination of distance and double-observer sampling. The Auk 123:735-752.