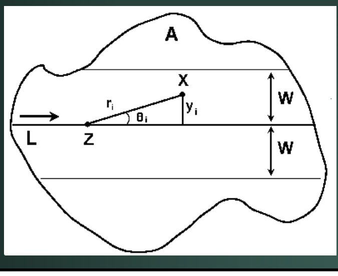
Distance Estimation of Abundance:

Assumptions and Possible Sources of Bias



General Approach

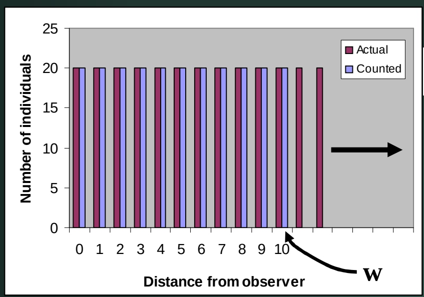
- Density is homogeneous within the survey area
- Some individuals go undetected
- Probability of detection is related to distance from the observer
- If we can assume all individuals at distance = 0 are detected, we can estimate the proportion that go undetected

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



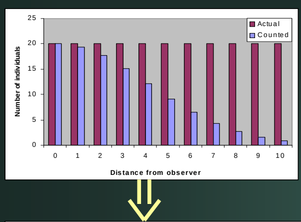
Line transect

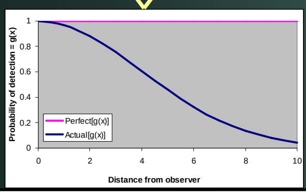
$$Abund = \frac{\#Counted}{2wL}$$

Point count

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

Abundance Estimation: Imperfect Detection





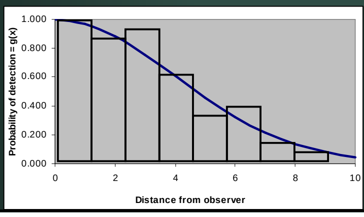
$$Abund = \frac{\#Counted}{ProportionDetected(PD)}$$

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

Abundance Estimation: Imperfect Detection

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

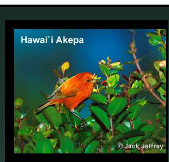
$$PD = \frac{\int_0^w Actual[g(x)] = fitted}{\int_0^w Perfect[g(x)] = 1 \times w}$$

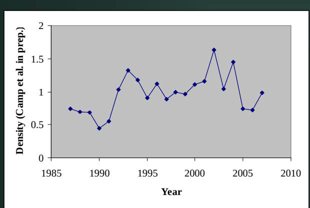


Effects of Behavioral Changes

- 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?

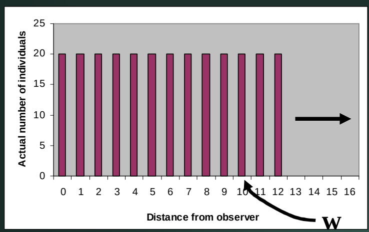
Hawaiian Akepa





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

Assumptions for Detectability Scenarios

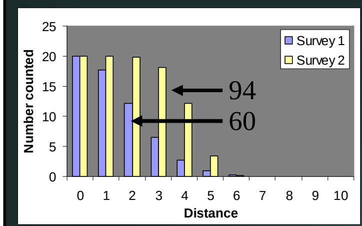


Line transect

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

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

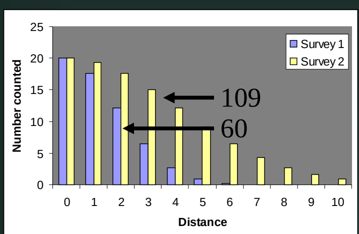
Scenario 1



- 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

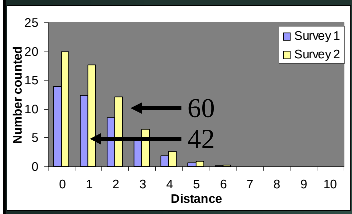


Increased detection
- more movement
- more singing

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



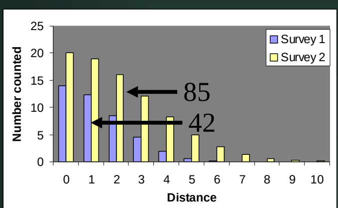
- Increased detection
  - more singing/calling
- Result
  - more detections within a maximum distance
  - increased detection at distance = 0

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 *Actual*[*g(0)*] < 1
  - 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.