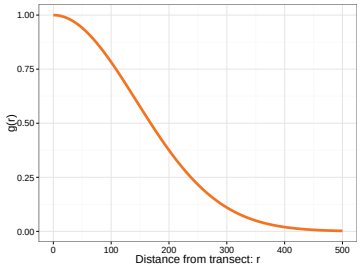
Detection Curve: $g(r)$



- Perfect Detectability Near to Observer, dropping off. The "shoulder"
- $g(r)$ = probability of detecting an object, given it is at distance r
- scaled so $g(0) = 1$

$$\hat{D} = \frac{n}{\text{Area} * P(\text{observing object}|\text{distance } r)}$$

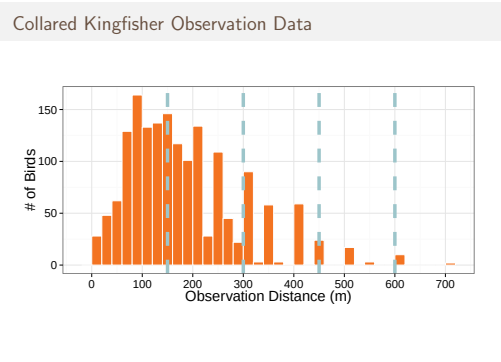
$$\hat{D} = \frac{n}{\text{Area} * g(r)}$$

- Much of the difficulty in distance sampling comes from estimating g(r)
- For this presentation, the kernel method, a non-parametric method, was used.
- in very broad terms, it looks at the average count per VCP and estimates area and probability by averaging over the observed observation distances inside a normal kernel.

Micronesian Forest Bird Survey: 1982

- Engbring, Ramsey & Wildman (1986)
- Used VCP to survey several bird species in the Micronesian islands
- Each of 5 Islands divided into regions
- Transect randomly placed within region (angle & starting position selected randomly)
- Stations placed every 150 m along transect
- Additional transects placed 2 km parallel

- Observers would wait 2 minutes after arrival, then spend 8 minutes observing all they could
- Distance and species were noted, as well as foliage and other variables.



- Aggregated over two islands, Rota & Tinan
- Aggregated over all observers, 4
- Primarily auditory cues, some visual, and some heard-then-seen
- Data tell us 3 main things
  - Very low bird counts immediately around the station. Some evidence o movement.
  - Evidence of heaping, the further away from station. More prominent with smaller bins.
  - Stations places 150 Meters Apart.

VCP Indepencence

- **ramsey1979**; **buckland1987**; **thompson2012** discuss assumption that VCPs are randomly placed.
  - Implicit, but not explicit, possibility of overlap
- **reynolds1980** state the possibility of observing the same bird from more than one station should be avoided.
- **buckland2001** states "Transects are normally spaced at a sufficient distance to avoid detecting an object from two neighboring transacts, although this is not usually critical unless sampling a line changes the animal distribution at neighboring, as yet un-sampled lines."

- Some Selected Quotes
- Literature is divided
- Transect layouts, similar to Micronesian study, are common
- We as scientists need to understand how this might bias our results.
- if layout is going to bias our results, then we need to be aware of that, so adjustments can be made to survey design or analysis.

Simulation Set Up

Modeled after Palie Region on Rota:

- 20 birds per km^2
- 9.41 km^2 Study Area
- Two transects, 16 & 17 stations each
- Truncation distance, w, taken to be 500 m

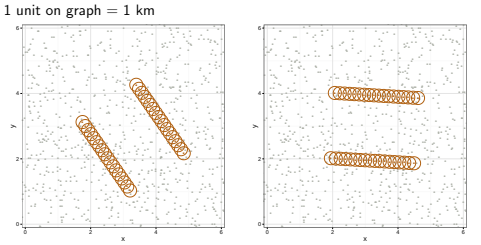
- Mainly because a density of $20/km^2$ was a nice round number.
- There is only 0.9 % of data beyond 500 m
- let me deal with nicer numbers, while still adhering to the spirit of the original data.

Variable Circular Plots: Station Placement and the Independence Assumption

Simulation

Transect Layouts

Transect Layouts

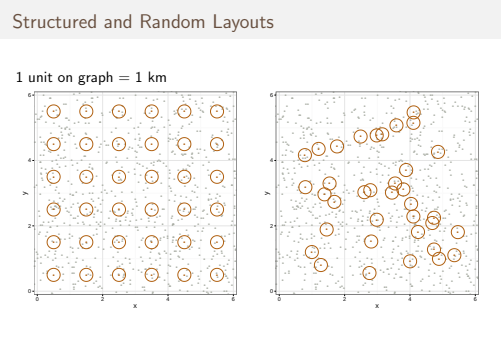


- 2 transects, 18 stations each
- angle randomly chosen
- starting position randomly chosen

Variable Circular Plots: Station Placement and the Independence Assumption

Simulation

Structured and Random Layouts



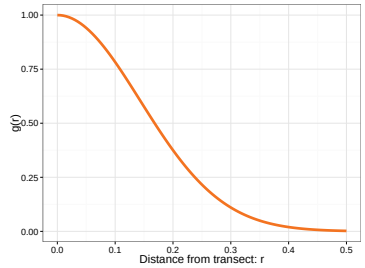
- Structured layout is why we're at 6km^2. needed to be able to have 500 m c direction in either area, without overlap
- this gave 36 stations, which was carried over to the other layout types.
- For Random Method, center point of VCP was randomly placed, within the buffer zone.

Variable Circular Plots: Station Placement and the Independence Assumption

Simulation

Detection Curve: Ideal

Detection Curve: Ideal

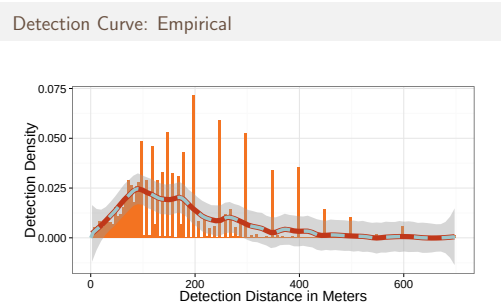


- A halfnormal curve, scaled so that $g(0.5)$ 0 and $g(0) = 1$
- used FDRTOOL package in R.

Variable Circular Plots: Station Placement and the Independence Assumption

Simulation

Detection Curve: Empirical



- data heaped into 5 m bins, midpoint of bin as x, density of bin * 5 as y
- Loess regression performed with a span of 2. This is solid line.
- Gives us object that can be used with predict function. Dashed line is estimate run with Predict to ensure.
- As with the half-normal, the density was scaled so that the highest point gave a probability of 1.
- with Predict, distances that extrapolated beyond the original dataset returned “na”, these were set to a probability of detection of 0.

Variable Circular Plots: Station Placement and the Independence Assumption

Simulation

Movement

- Based on the empirical observations, movement was simulated within the first 100 m from observer
- Higher chance of movement if closer to observer
- Moved further if originated closer to observer.

Movement

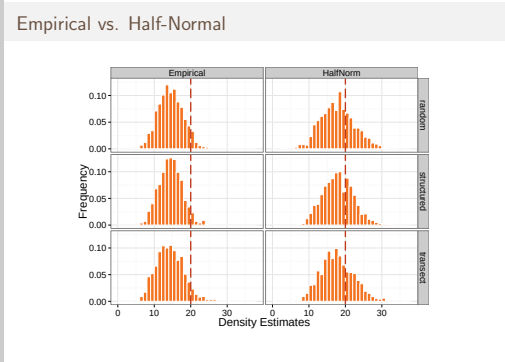
Three Movement Options:

- No Movement: Objects stayed at origin point
- Temporary Movement: Objects would shift away from observer, but shift back to origin after observer "left"
- Compounded Movement: Objects would shift away from observer, would remain at new point after observer moved. (Movement could compound if object was within movement radius for more than one VCP)

Variable Circular Plots: Station Placement and the Independence Assumption

Results

Empirical vs. Half-Normal



- 1000 Simulations. Each object layout was analyzed with the 6 combination represented in the graph
- Density estimates done using the kernel method with a normal kernel (**quang1993**)
- Estimates for Empirical detection function biased low.
- Estimates using half-normal detection function biased low, but not as bad.

Variable Circular Plots: Station Placement and the Independence Assumption

Results

Empirical vs. Half-Normal

Empirical vs. Half-Normal

Centers and Spread

$g(x)$	Layout	Mean	Std Dev	25th	Median	75th
Empirical	Random	14.47	3.37	12.08	14.38	16.73
Empirical	Structured	14.49	3.15	12.27	14.47	16.59
Empirical	Transect	14.26	3.66	11.65	14.14	16.80
Half-normal	Random	17.90	4.57	14.67	17.86	20.88
Half-normal	Structured	18.03	4.16	15.05	17.91	20.82
Half-normal	Transect	17.80	4.64	14.52	17.44	20.78

- supports graphic: Centers vary between detectability options, but not much between layouts.
- May be some evidence of a downward shift with the Transect Layout. Can observe in Empirical mean & median, and Half-normal Median.
- Hard to say if this is true effect or something else.

Variable Circular Plots: Station Placement and the Independence Assumption

Results

Empirical vs. Half-Normal

Empirical vs. Half-Normal

True Density Capture

	Empirical		Half Normal	
Layout	Mean $\hat{D}$	% Capture	Mean $\hat{D}$	% Capture
Random	14.47	73.6%	17.90	94.0%
Structured	14.49	77.5%	18.03	95.3%
Transect	14.27	69.6%	17.80	91.2%

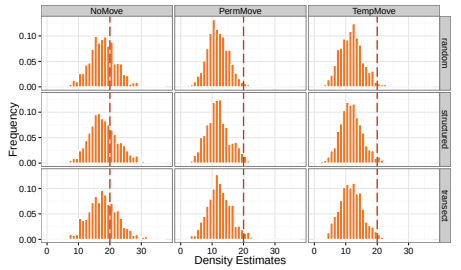
- Again, Transect layout may have some downward trend, as the capture percentages are lower here
- Everything is relative. We have a larger up-tick in the Empirical/Structured cell than for Half-Normal and Structured.
- Repeated runs of the simulation, and higher simulation counts could help determine if this is a significant pattern.

Variable Circular Plots: Station Placement and the Independence Assumption

Results

Movement Results

Movement Results



- 1000 Simulations. Again, each object layout was analyzed with the 9 combinations represented in the graph
- Density estimates done using the kernel method with a normal kernel (**quang1993**)
- Again, layout does not seem to play as large of a part as the other factor.
- All were run with half-normal detectability function

Movement Results
Centers & Spread

Movement	Layout	Mean	Std Dev	25th	Median	75th
None	Random	17.86	4.28	15.03	17.64	20.65
None	Structured	18.01	4.51	14.95	17.62	20.94
None	Transect	17.90	4.78	14.74	17.67	20.95
Compounded	Random	11.86	3.42	9.58	11.61	14.09
Compounded	Structured	11.90	3.65	9.37	11.67	14.08
Compounded	Transect	12.42	3.72	9.93	12.17	14.79
Temporary	Random	11.76	3.57	9.22	11.75	14.02
Temporary	Structured	11.74	3.48	9.37	11.56	13.85
Temporary	Transect	11.75	3.57	9.24	11.72	14.20

- Reinforced histograms: results consistent within movement type, regardless of layout type
- No Movement is consistent with what was observed in initial simulation
-

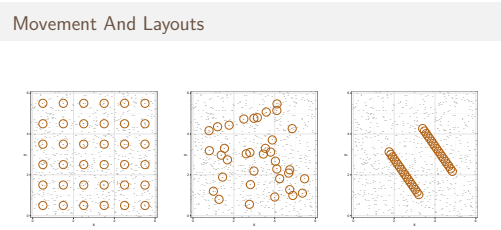
	No Movement		Compounded		Temporary	
Layout	Mean $\hat{D}$	%	Mean $\hat{D}$	%	Mean $\hat{D}$	%
Random	17.86	94.2%	11.86	59.6%	11.76	59.3%
Structured	18.01	94.3%	11.90	59.9%	11.74	59.5%
Transect	17.90	90.8%	12.42	65.0%	11.75	58.0%

- Movement type does not appear to play a large part in changing the bias.
- We capture the true density about 59% of the time, regardless of movemen type.

Variable Circular Plots: Station Placement and the Independence Assumption

Results

Movement And Layouts



- Makes sense for structured, if the objects are only moving within the first 100 m, they would not move twice.
- For the Randomized Layout, there are only 3, in this example, where there a significant amount of overlap. If we take this as representative of the population of layouts, we would not be seeing many layouts with a significant amount of double or triple movement. An estimate from this layout should be similar to the Structured Layout, which we see.
- It's with the Transect layout where the most compounded movement occur
- (Go Back 1 Slide) There may be an effect of the combination of The Compounded movement and the Transect layout.
- not sure if this is bias reduction, or an upward bias that looks like bias reduction because we're already low.

└Conclusion

If all else is held equal, VCP layout does not seem to play a large role in the bias of population density estimates using the kernel method described by **quang1993**

Violations of the expected detection probability curve, or by movement of the objects away from the observer play a greater role in biasing the resulting estimate.

- All of the estimates were biased low using Quang's formula
- this was observed even with an "ideal" half-normal detection curve
- Dr. Quang's paper does offer a bias-corrected estimate, but it was not used for this project.