Point transect sampling

Random points or systematic grid of points randomly placed; observer records distance to any detected animals.
Point transect sampling

For $k$ point counts with certain detection to distance $w$:

$$\hat{D} = \frac{n}{k \pi w^2}$$

How does this change if detection is uncertain?
Effective radius and effective area

\[ \nu = \pi \rho^2 \]

\[ \pi w^2 \]

\( \rho = \text{effective radius} \)

\( \nu = \text{effective area} \)
Covered area: \[ a = k \pi w^2 \]

Proportion detected: \[ P_a = \frac{k \pi \rho^2}{k \pi w^2} = \frac{\rho^2}{w^2} \]

Estimated density: \[ \hat{D} = \frac{n}{a \hat{P}_a} = \frac{n}{k \pi w^2 \times \hat{\rho}^2 / w^2} = \frac{n}{k \pi \hat{\rho}^2} \]
Area and hence number of birds increase linearly with distance:
Probability density function

\[ f(r) \]

\[ \text{freq} \quad \text{(scaled)} \]

\[ w \quad r \]
Detection function
Line transect

Point transect

Detection function $g(x)$

Observed distribution
The effective radius \( \rho \) ...

... is the distance such that as many birds beyond \( \rho \) are detected as are missed within \( \rho \) of the point.
Area under curve:
\[ \int_{0}^{w} f(r) dr = 1 \]

Area of triangle:
\[ \frac{\rho \times \rho f'(0)}{2} = \frac{\rho^2 h(0)}{2} \]

Hence \( \hat{\rho}^2 = \frac{2}{\hat{h}(0)} \) and \( \hat{v} = \frac{2\pi}{\hat{h}(0)} \)

so that \( \hat{D} = \frac{n\hat{h}(0)}{2\pi k} \)

Slope = \( h(0) \)
Notation: point transects

Known constants and data:

$k$ = number of points

$n$ = no. of animals or clusters detected

$r_i$ = distance of $i^{th}$ detected animal or cluster from the point, $i = 1, \ldots, n$

$w$ = truncation distance for $r$

$A$ = size of region of interest

$a$ = size of covered region = $k\pi w^2$

$s_i$ = size of $i^{th}$ detected cluster, $i = 1, \ldots, n$
Point transect notation (cont)

Functions:

\( g(r) = \) detection function
\( f(r) = \) probability density function (pdf) of detection distances
\( h(r) = f'(r) = \) slope of pdf \( f(r) \)
\( h(0) = \) slope of pdf evaluated at \( r=0 \)
Point transect notation (cont)

Parameters:

- $D = \text{density} = \text{animals per unit area}$
- $D_s = \text{density of clusters}$
- $N = \text{population size} = D \cdot A$
- $\rho = \text{effective radius} = \sqrt{2 / h(0)}$
- $\nu = \text{effective area (per point)} = 2\pi / h(0)$
- $P_\alpha = \text{prob. of detection of animal or cluster in the covered area} \, a$