Advanced Distance Sampling - Intro

26 August 2019 09:01

How many animals are there?

- Distance sampling
- Complete census
- Mark-recapture / capture-recapture. — easy; animals in hand; targeted sampling
  can get sex ratio, age class
  survival estimation possible
  → broad down

$\hat{N} = \frac{n}{\hat{p}}$ ← Horvitz-Thompson-like estimation

Estimating density hard!

$D = \frac{N}{A}$

Problem: if unmodelled capture heterogeneity means $\hat{p}$ biased high so $\hat{N}$ biased low

Bill Link (2014) "The curse of link"

- Spatial capture recapture (SCR / SECR)

  Takes into account location of capture ⇒ estimate density
  Tackles a major source of heterogeneity — distance from home range centre

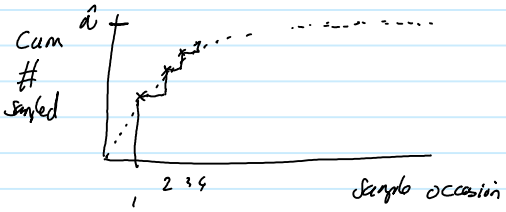
- N mixture models

  Link + Barker
  Barker + Link
  } — 2 recent papers

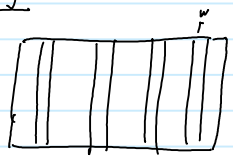
  ① When assumptions not, not robust
  ② When assumptions not met, wrong answer + hard to detect.

- Plot sampling → Strip transect
  → Quadrat.
  } aerial sampling.

- Removal sampling



Plot sampling



width $= 2w$
Length $= L$ → total length $L = \sum l$
Total area sampled $= 2wL$
Study area size: A
Count n animals

$\hat{N} = \frac{n}{2wL} \times A$ $\hat{D} = \frac{n}{2wL}$

Assumptions: —

- Closed population / snapshot
- detect everything in plots
- samples represent population ⇒ random sampling ← design issue

k: # lines

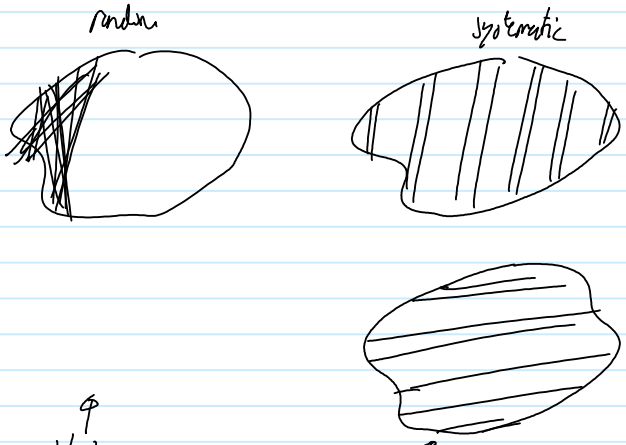
Variance:

Fewster et al (2009) var R2 $\hat{var}\left(\frac{n}{L}\right) = \frac{k}{L^2(k-1)} \sum^{k} l_i^2 \left(\frac{n_i}{l_i} - \frac{n}{L}\right)^2$

Variance:

Fewster + al (2009) var R2 $\widehat{var}\left(\frac{n}{L}\right) = \frac{K}{L^2(K-1)} \sum_{i=1}^{n} l_i^2 \left(\frac{n_i}{l_i} - \frac{n}{L}\right)^2$

Robust variance estimator
Assumes random line placement.



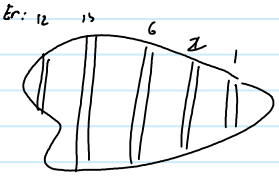
Line variance: Higher Lower

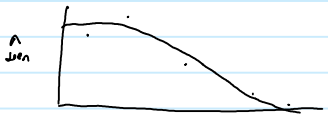
Estimating variance "Easy" "Hard"

solutions: Use random variance estimator ⇒ overestimate of variance

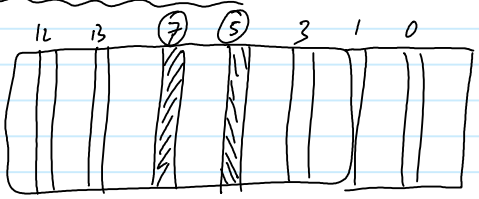
Use Fewster (2011) trick part of fitting ⇒ better estimate of variance.

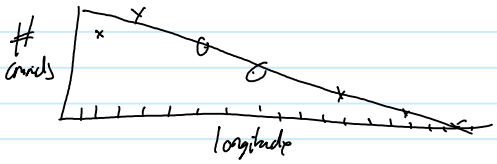
Use Fewster (2011) model-based variance "stipleti"





Model-based estimation of abundance





Abundance estimate comes from model.

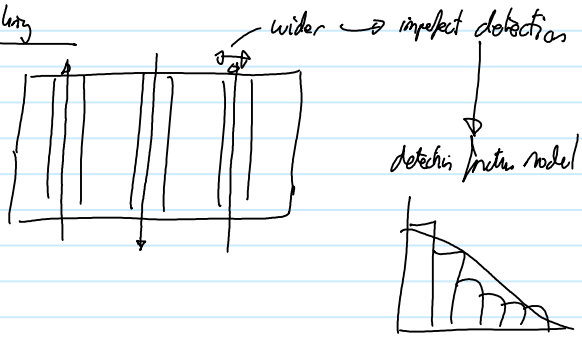
Good :- No design needed :- Increased understanding of animal distribution
:- Potentially get lower variance - explaining variation
:- Predict density in small parts of study area.

Bad :- More complex.
:- Answer only as good as the model

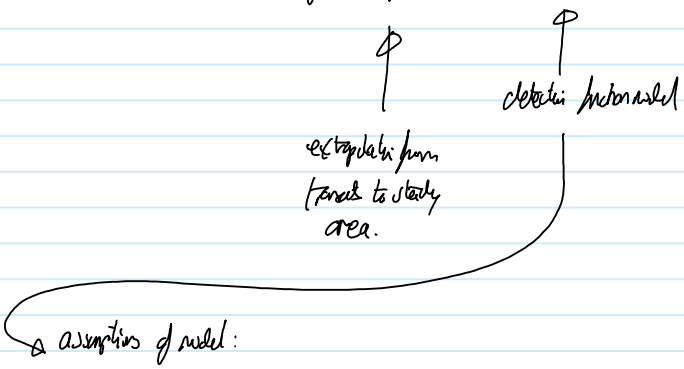
Design-based strategies to minimize variance

- Line orientation – lines parallel to density gradient
- Stratification
- Systematic design

Distance sampling



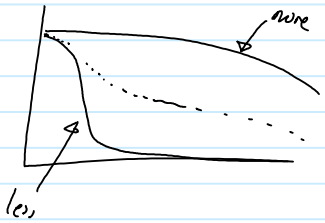
Distance sampling – a mix of design-based & model-based



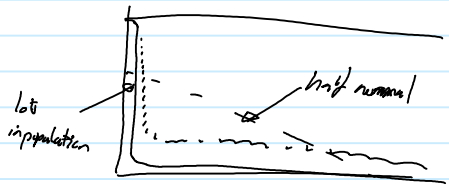
assumptions of model:

- perfect detection at 0 distance.
- animal distribution independent of transect distribution ← true because of random line placement.
- distances accurate
- no animal movement / snapshot
- each detection is independent of each other ← not important

Pooling robustness: heterogeneity of detection probability between animals.



No bias caused – except when extreme:–



PLAN: Model-based distance sampling – Mon-Weds
- Imperfect detection on line – Thursday am
- Simulation – Thursday.
- Movement
- Passive acoustics

Marenat
Passive acoustics
SCR
Multi analysis DS
Availability

} Friday am

Buddland – robust methods for songbirds The Auk.