Survey design

- Introduction
- Point transect designs
- Line transect designs
- Stratification

See

- Chapter 7 of Buckland et al. (2001) Introduction to Distance Sampling
- Chapter 2 of Buckland et al. (2015) Distance Sampling: Methods and Applications

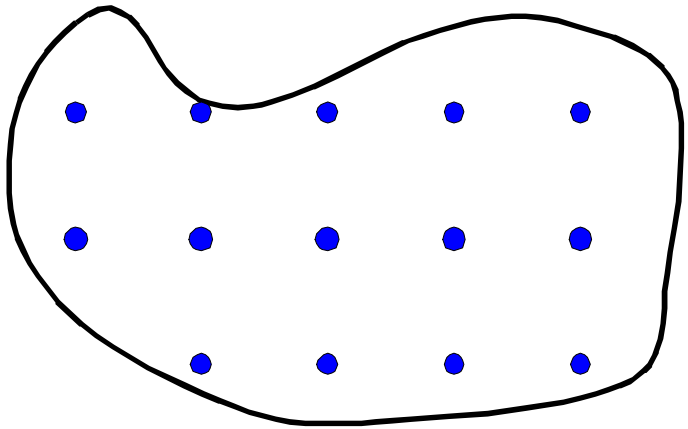
Survey design – things to consider

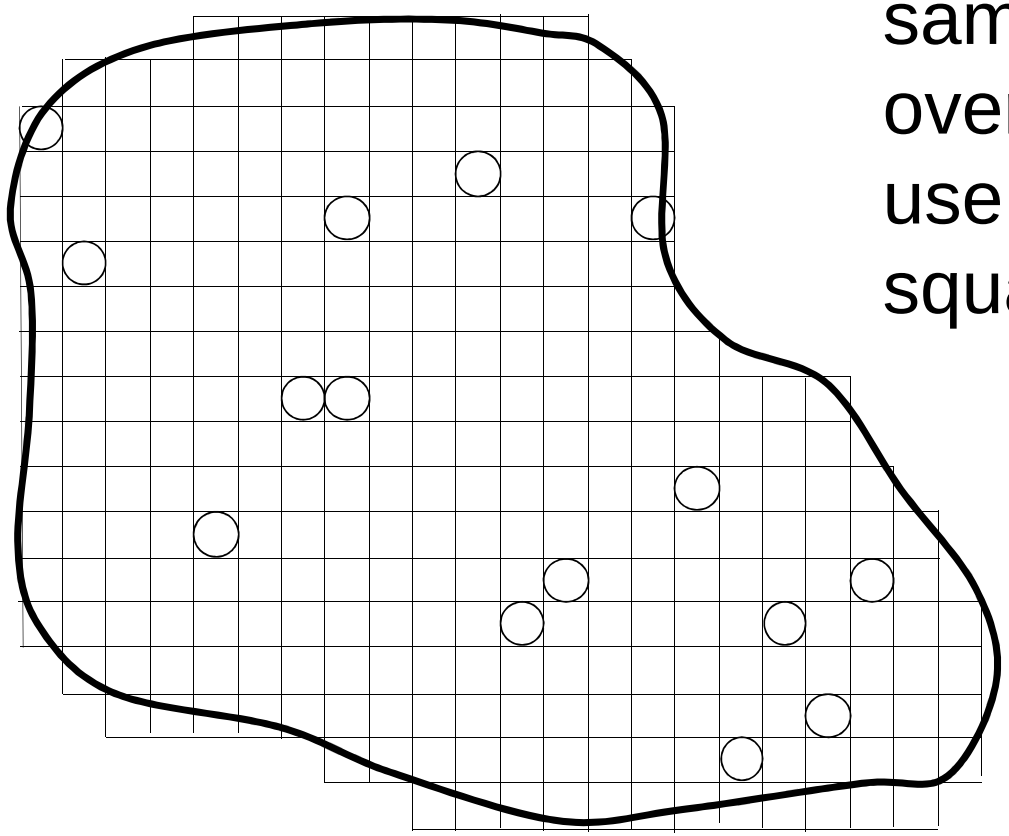
- What are your objectives?
- What precision do you need?
- What resources are required?
- Are sufficient resources available?
- Include training in the costings.
- Cost for statistical advice!!
- Conduct a pilot survey.

Line or point placement

- Use randomly positioned lines or points, or a systematic grid of lines or points, randomly superimposed on the study area
- **Do not** use roads, tracks, etc.
- Stratify the study area if strong differences in habitat or density are apparent
- Aim to orientate lines perpendicular to density contours or to linear features (e.g. woodland edge)
- Many short lines are preferred to a few long lines

Point transect survey design

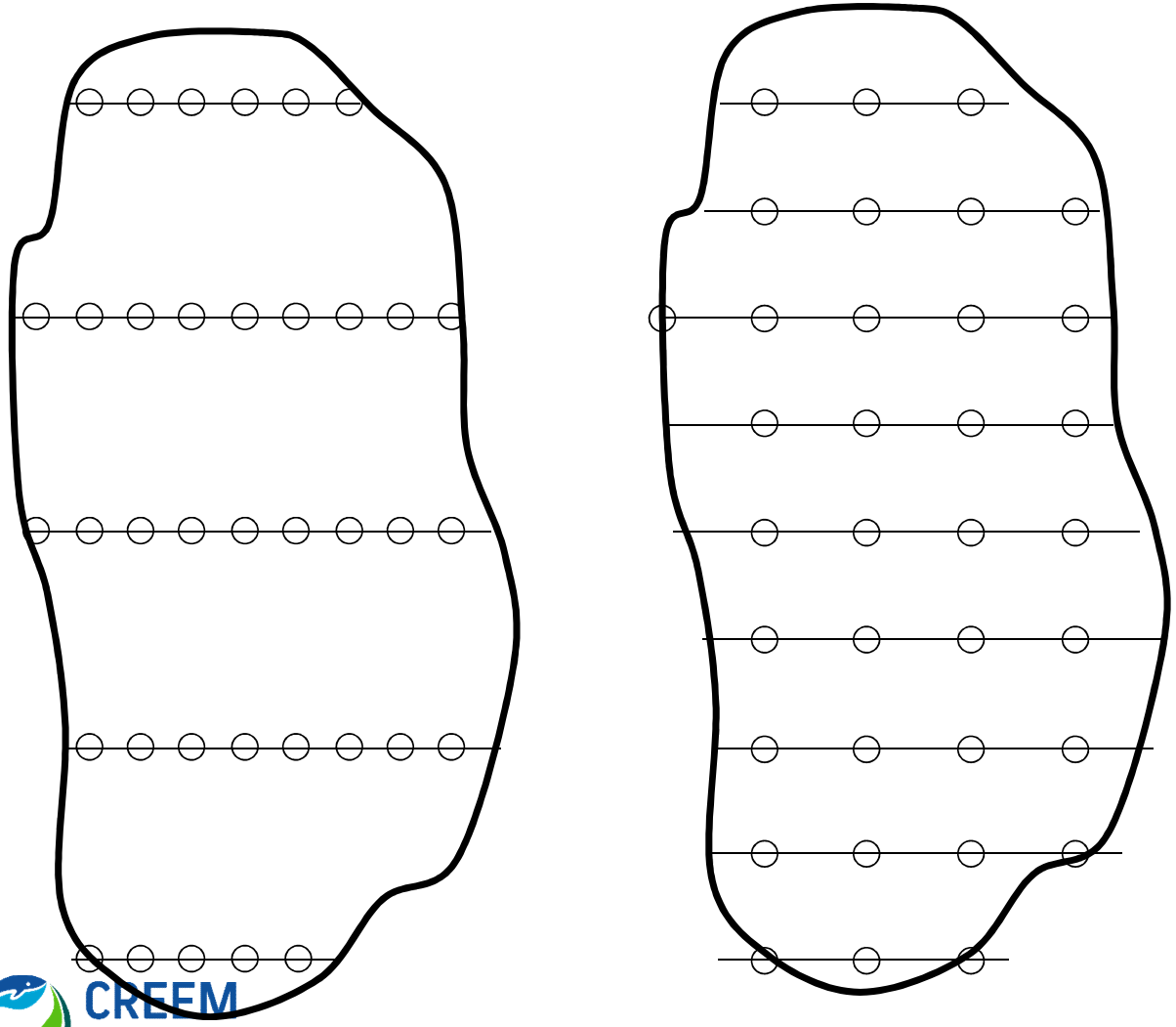




Simple random sampling without overlapping plots: use a grid of squares of side 2*w*

CREEM
Centre for Research into Ecological and Environmental Modelling

University of St Andrews



Points along lines:

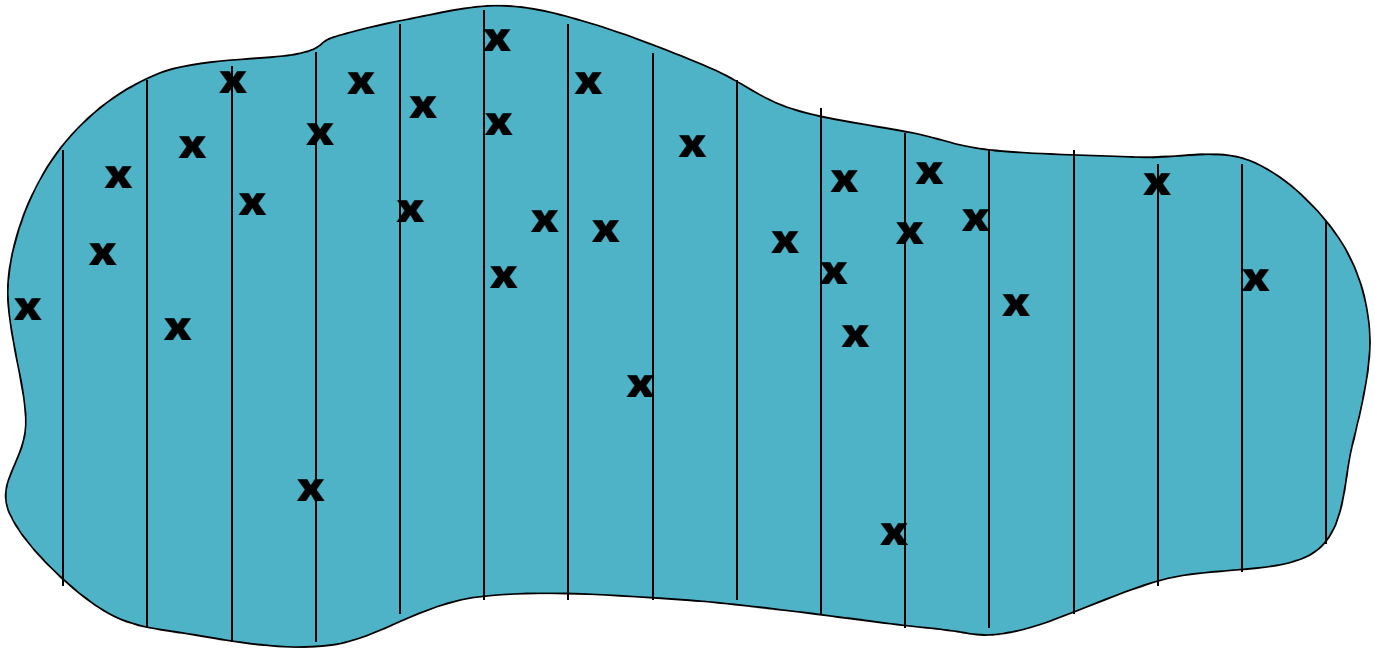
Left-hand design: the lines should be taken as the sampling units,

Right-hand design: the individual points can be taken as the sampling units

CREEM
Centre for Research into Ecological and Environmental Modelling

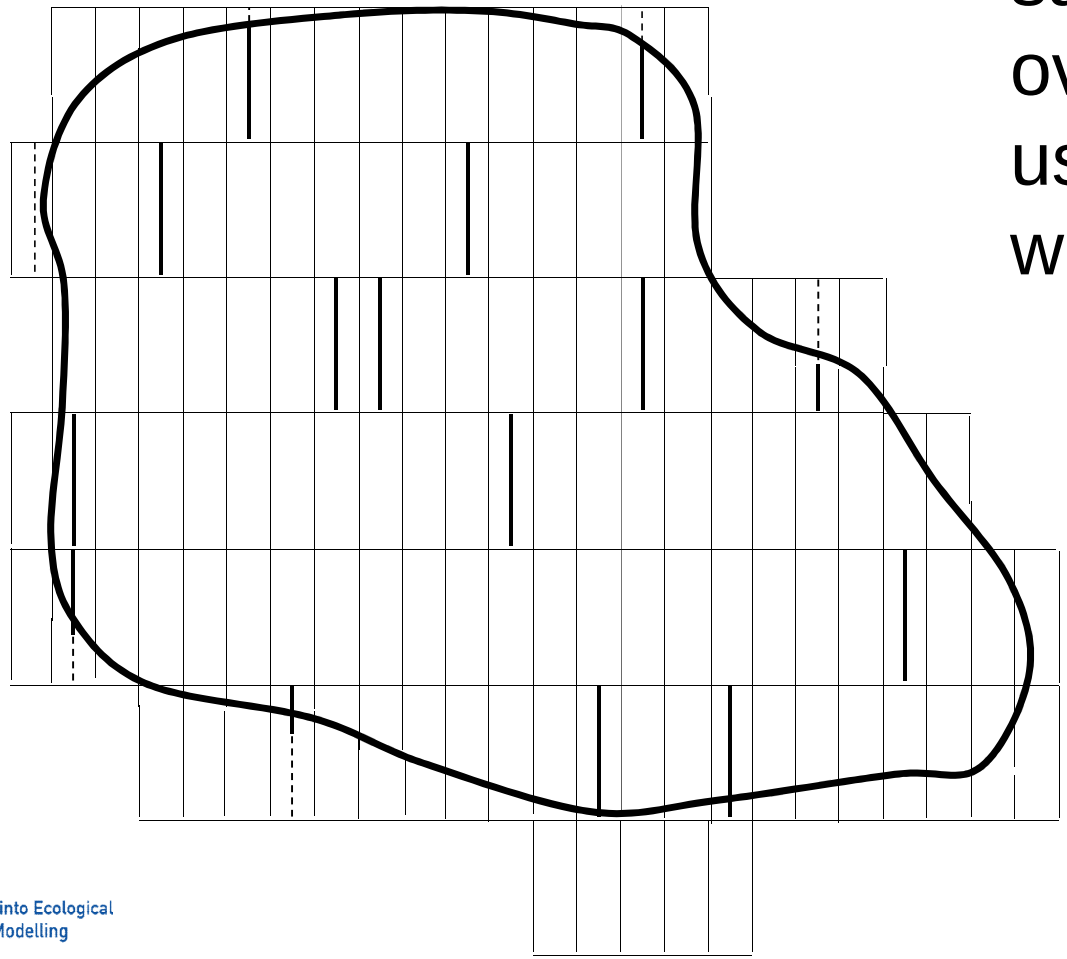
University of St Andrews

Line transect survey design



CREEM
Centre for Research into Ecological and Environmental Modelling

University of St Andrews

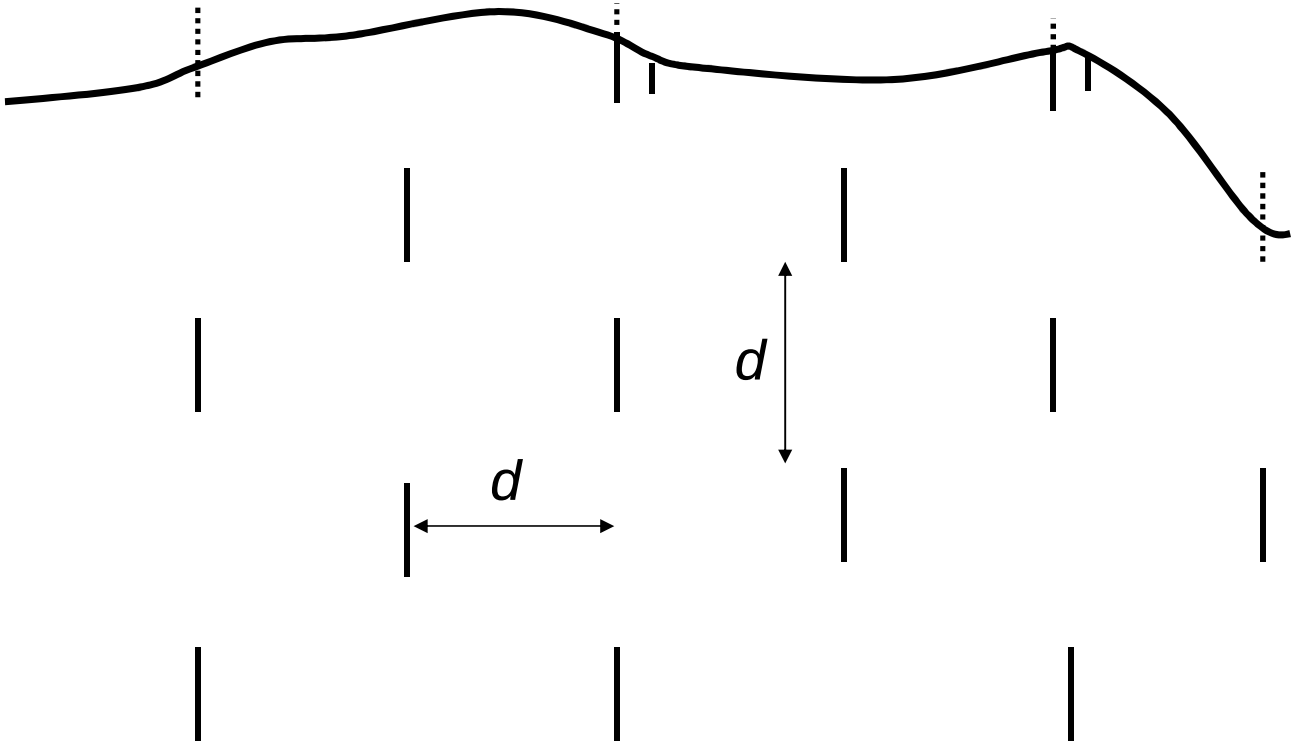


Simple random sampling without overlapping strips: use a grid of rectangles width 2*w* and length *l*

CREEM
Centre for Research into Ecological and Environmental Modelling

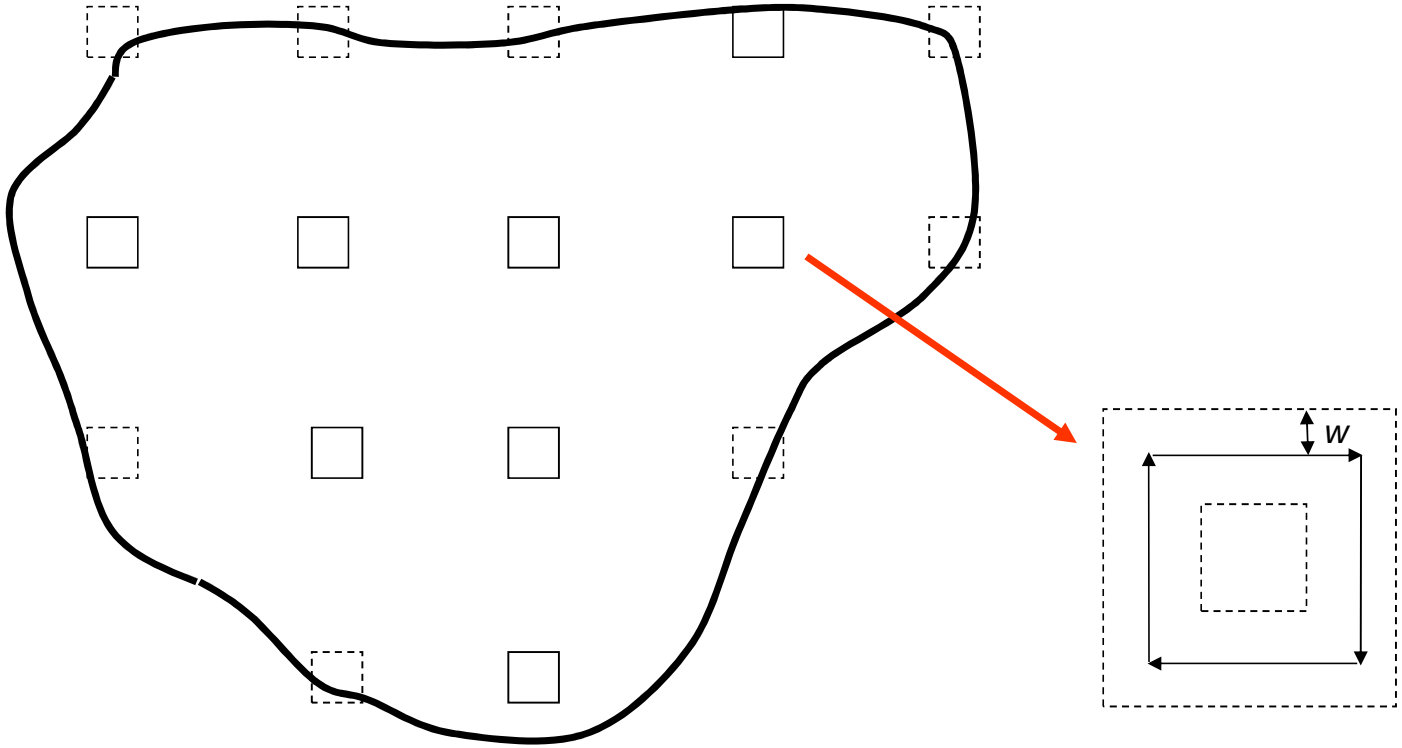
University of St Andrews

A systematic segment design



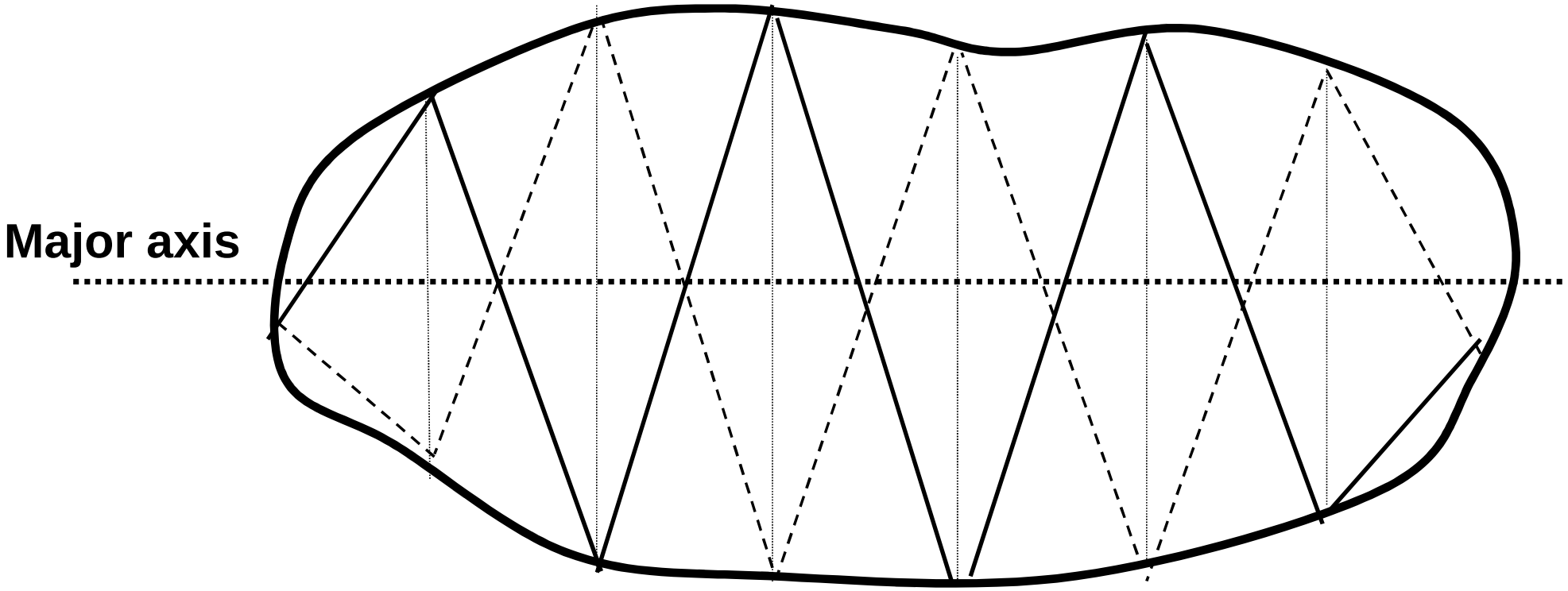
(See later lecture for strategies to deal with segments that intersect the study area boundaries (“edge effects”.)

A circuit design



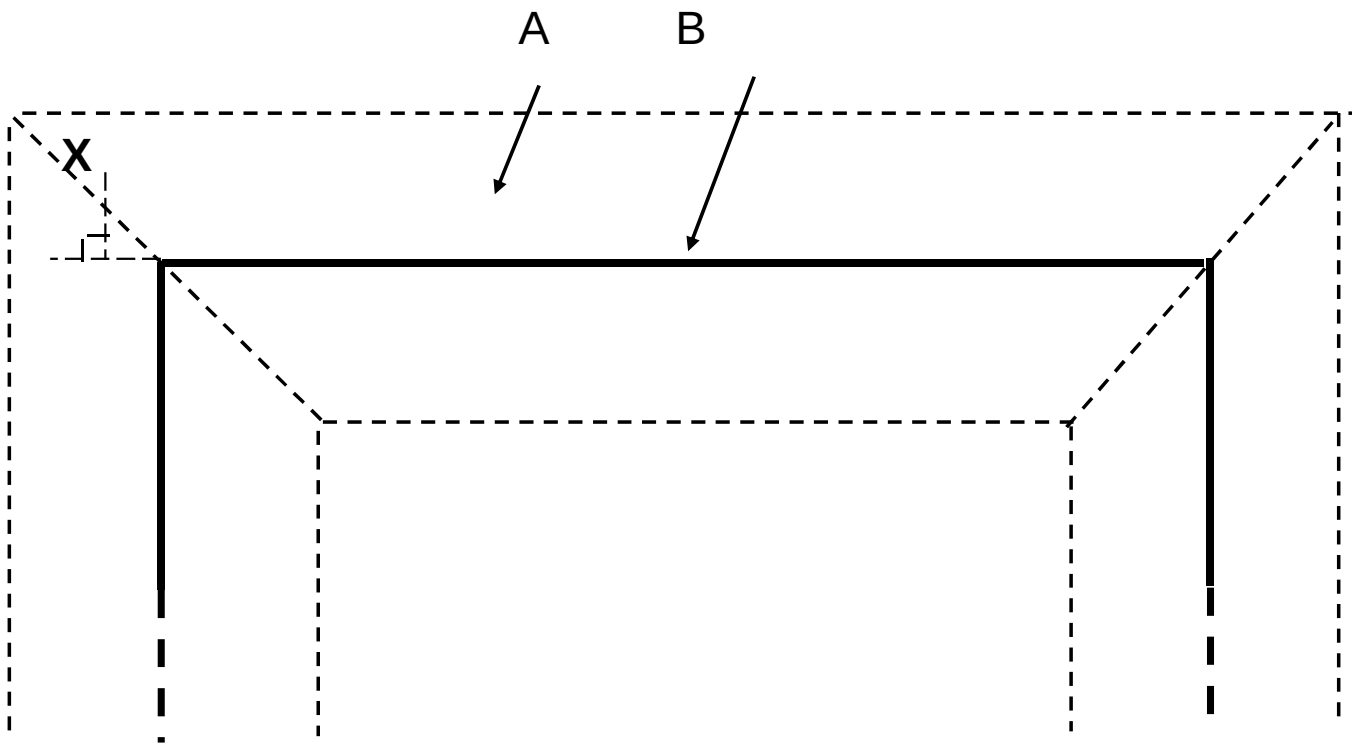
(Again, see later for how to deal with edge effects.)

Saw-tooth or zigzag designs

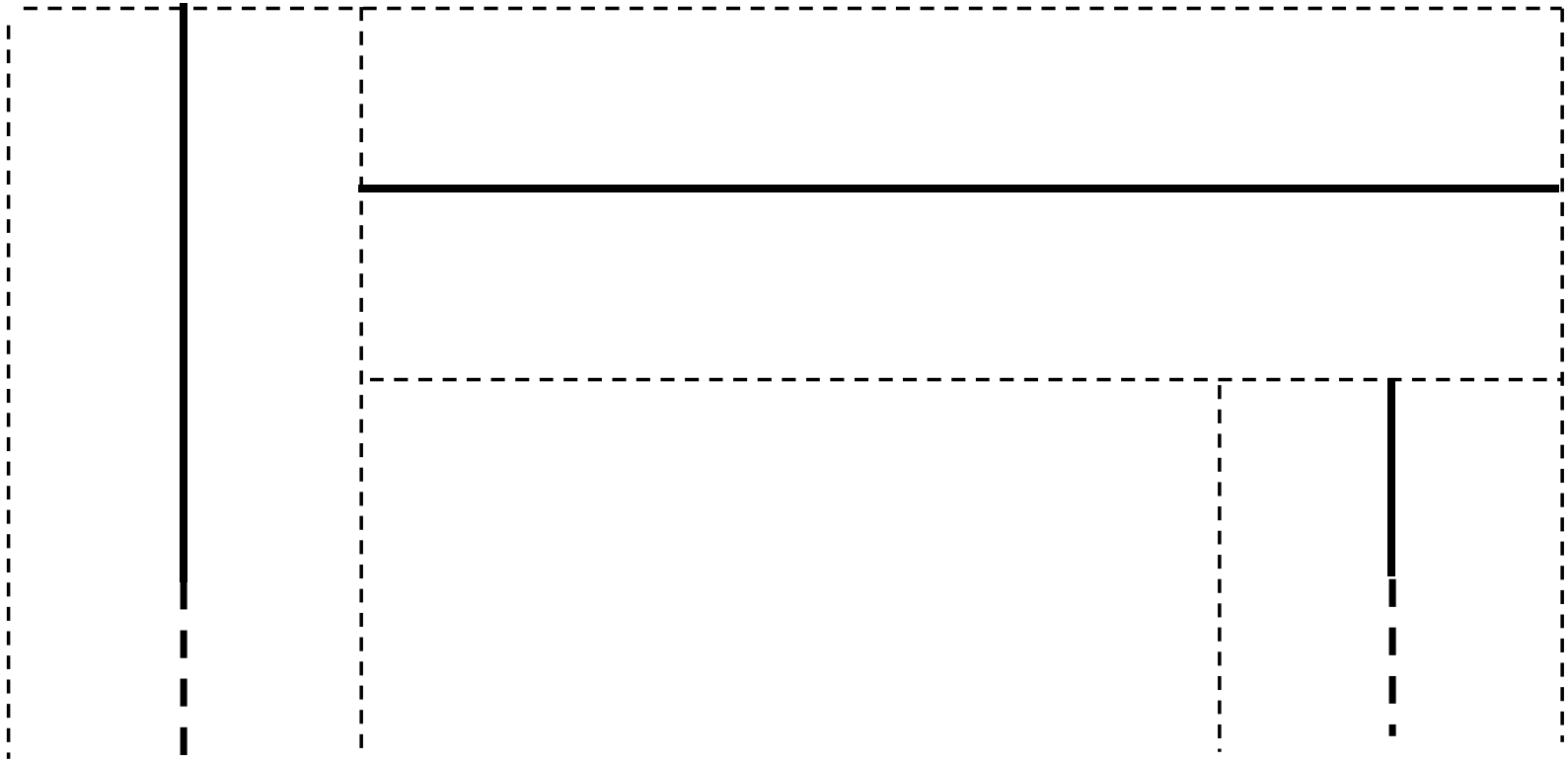


Corners in saw-tooth and circuit designs:

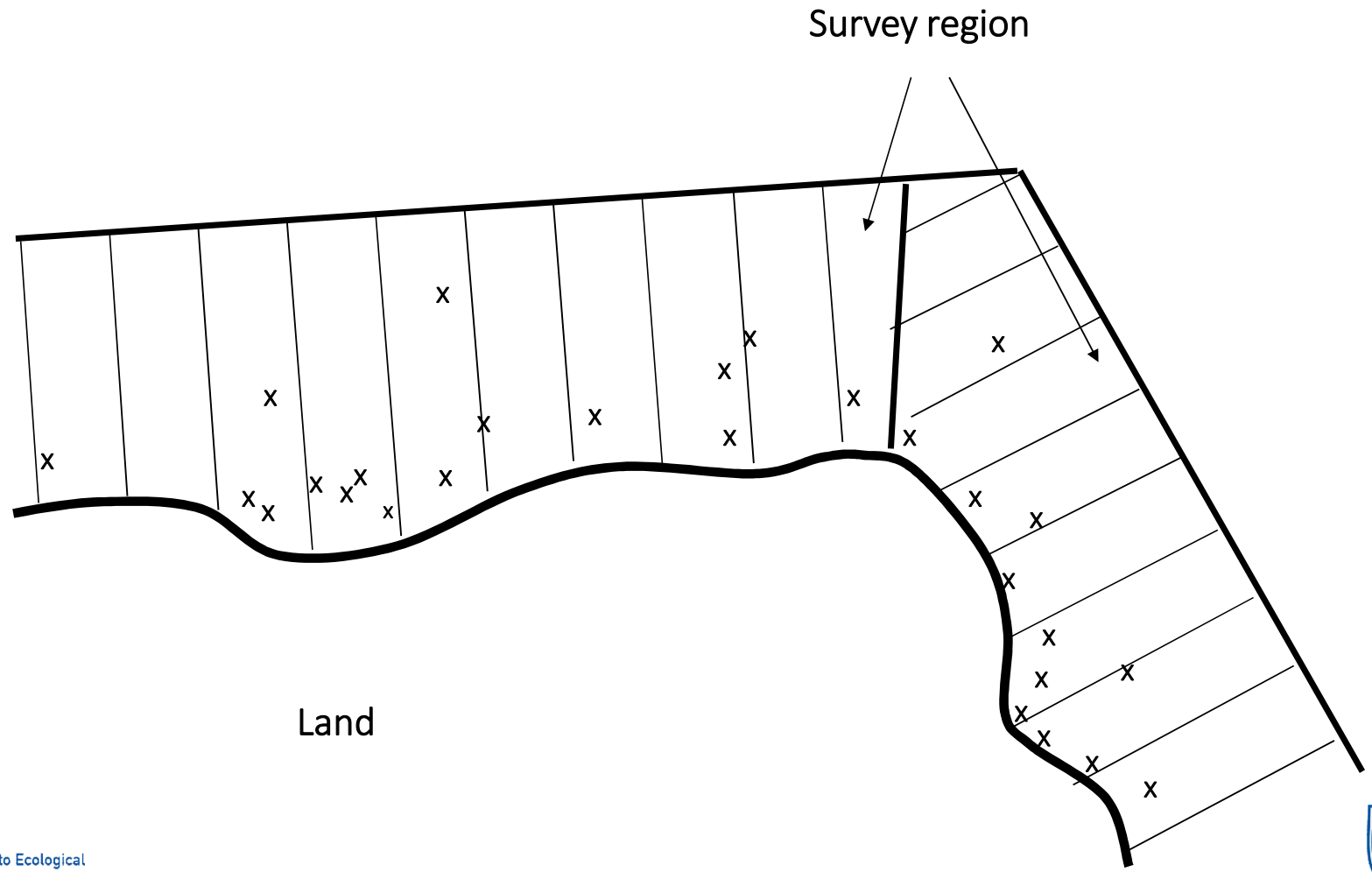
Animal X is detected in trapezium A, so is associated with line segment B



Right-angle corners:



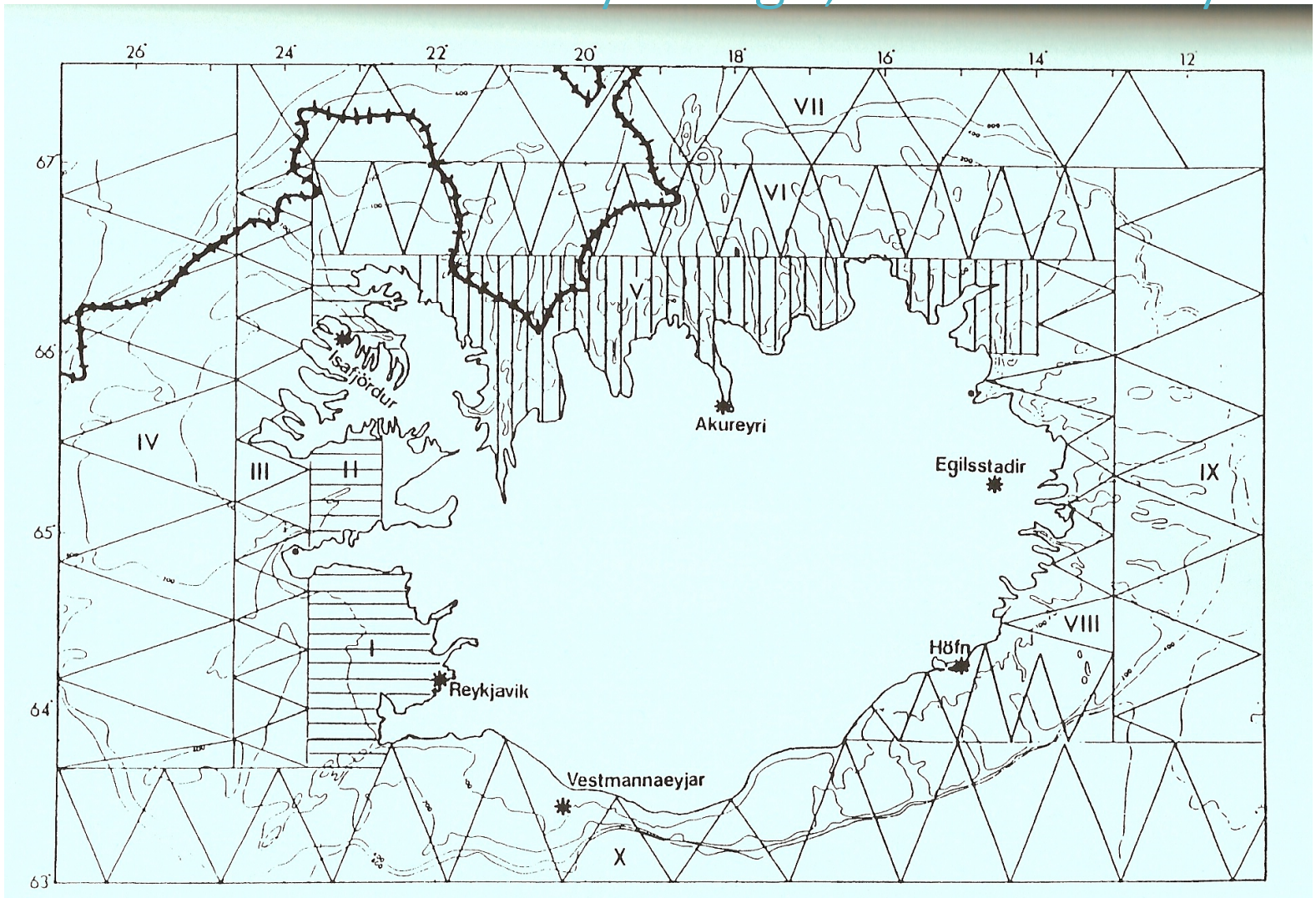
Designing an inshore survey



CREEM
Centre for Research into Ecological and Environmental Modelling

University of St Andrews

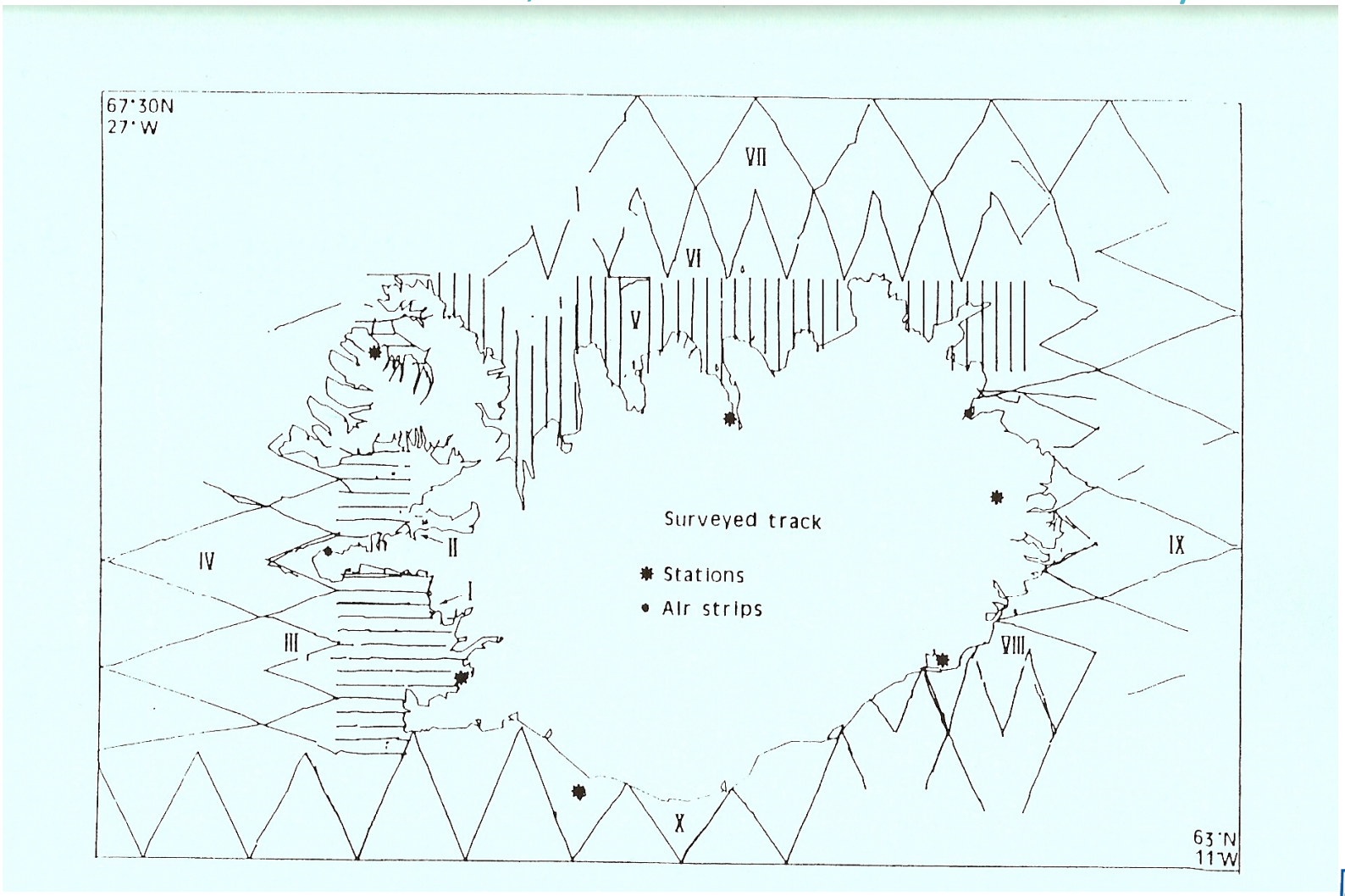
Iceland – aerial survey design, whale survey



CREEM
Centre for Research into Ecological and Environmental Modelling

University of St Andrews

Actual effort, Icelandic whale survey



CREEM
Centre for Research into Ecological and Environmental Modelling

University of St Andrews

Stratification (Geographic)

Why stratify?

- To improve precision.
  - *Estimate inter-stratum differences rather than have them contribute to variance.*
  - *Reduce overall variance by increasing effort in strata which contribute most to variance.*
- Because want estimates by sub-region/stratum.
- For logistic reasons

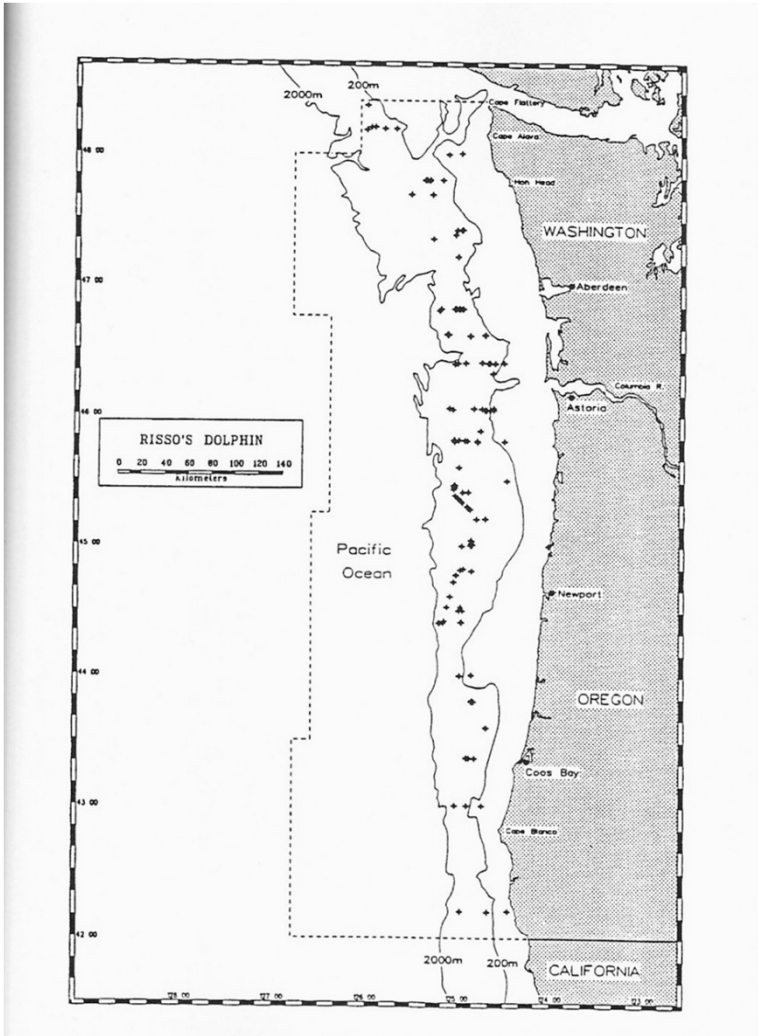
Stratification (Geographic)

What to stratify?

- Encounter rate: Density often varies spatially.
- Detection function: May vary spatially. There are often sample size limitations on stratified estimation (too few detections in some strata).
- Mean cluster size: May vary spatially. There may be sample size limitations on stratified estimation.

NB: If any of the above are estimated by pooling across strata, when in reality they differ between strata, within-stratum estimates are biased.

Stratification (Spatial)

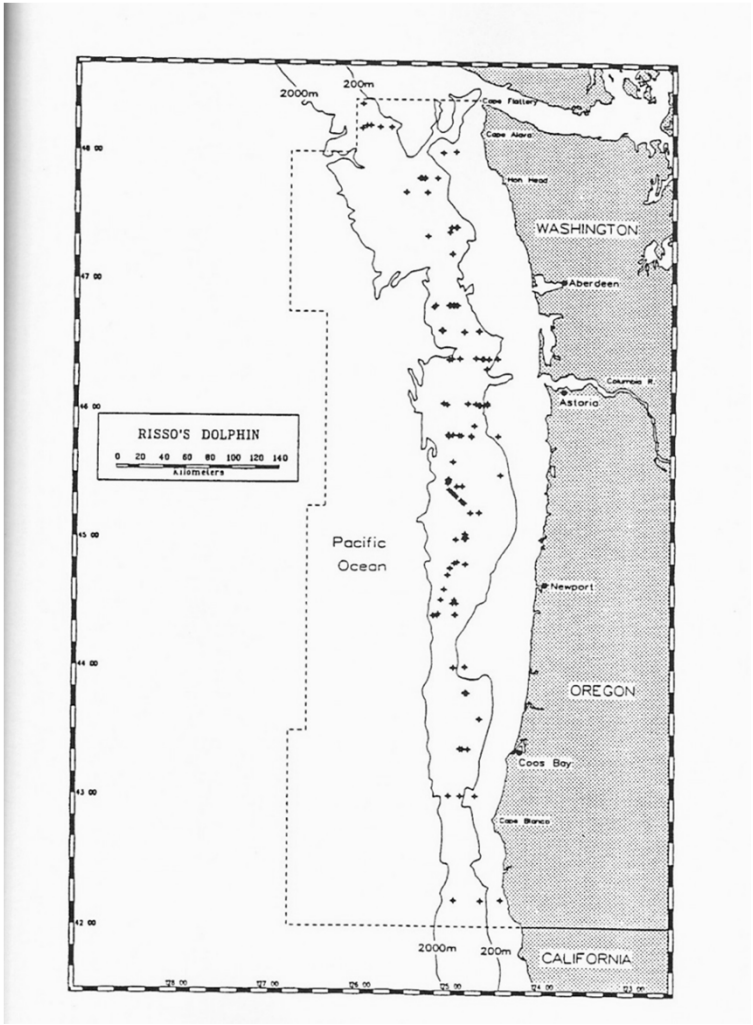


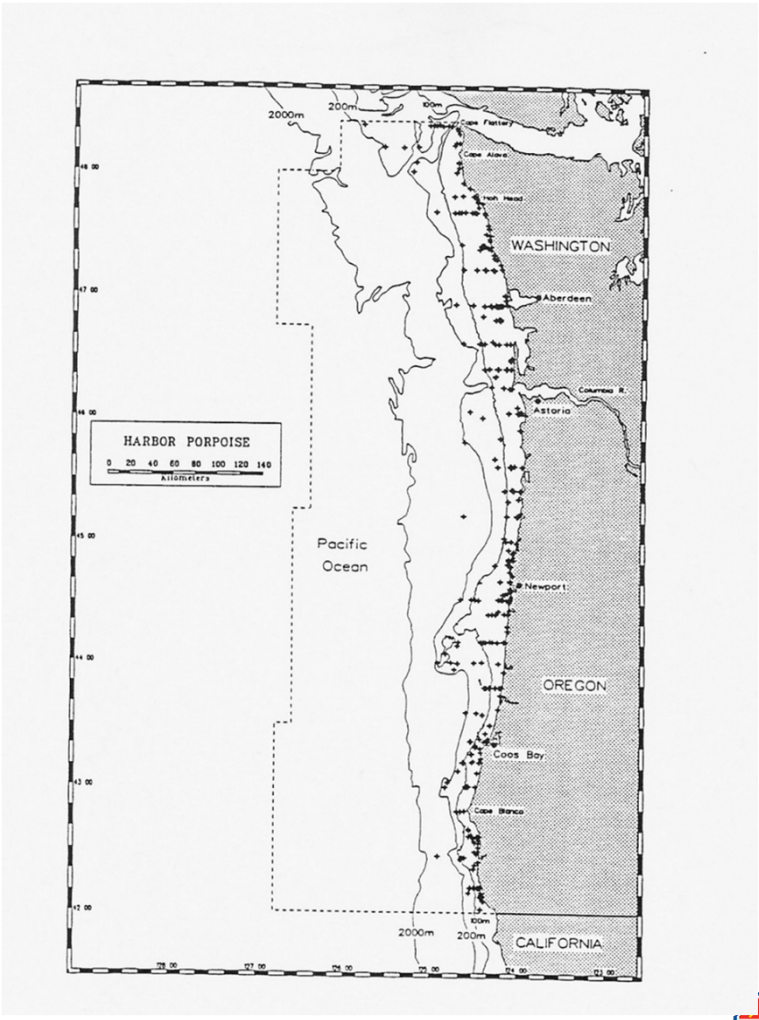
- Most animals between 200m and 2000m contours, so put more effort into a shelf-edge stratum?
- But:
- Sample size too low in other strata?
- Other species?

CREEM
Centre for Research into Ecological and Environmental Modelling

University of St Andrews

Stratification (Spatial)

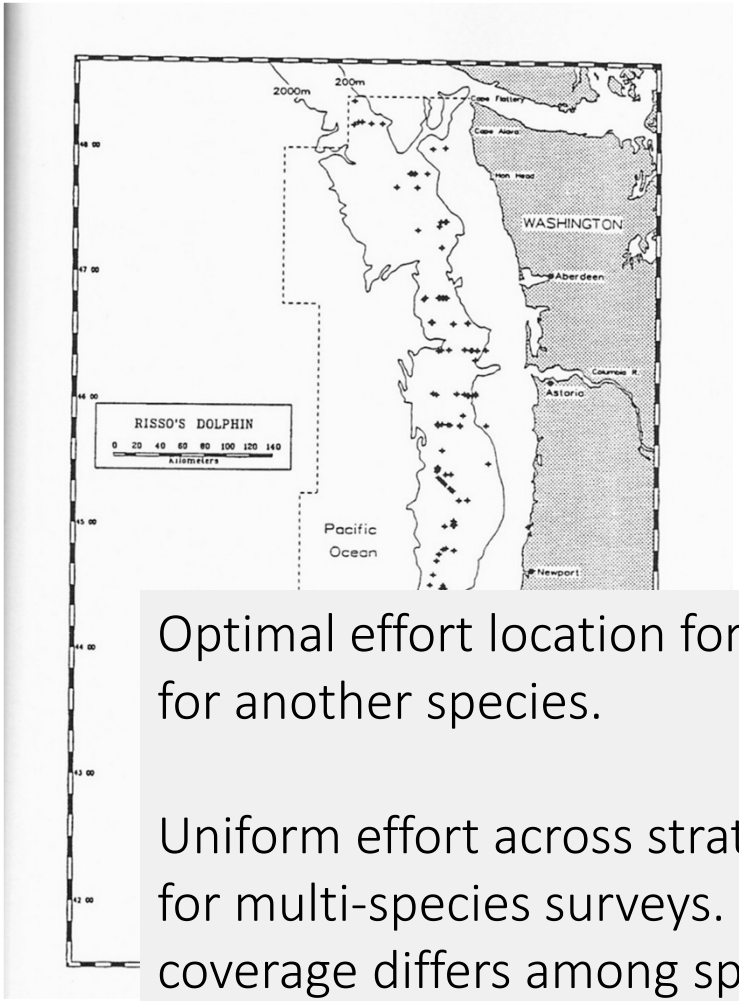


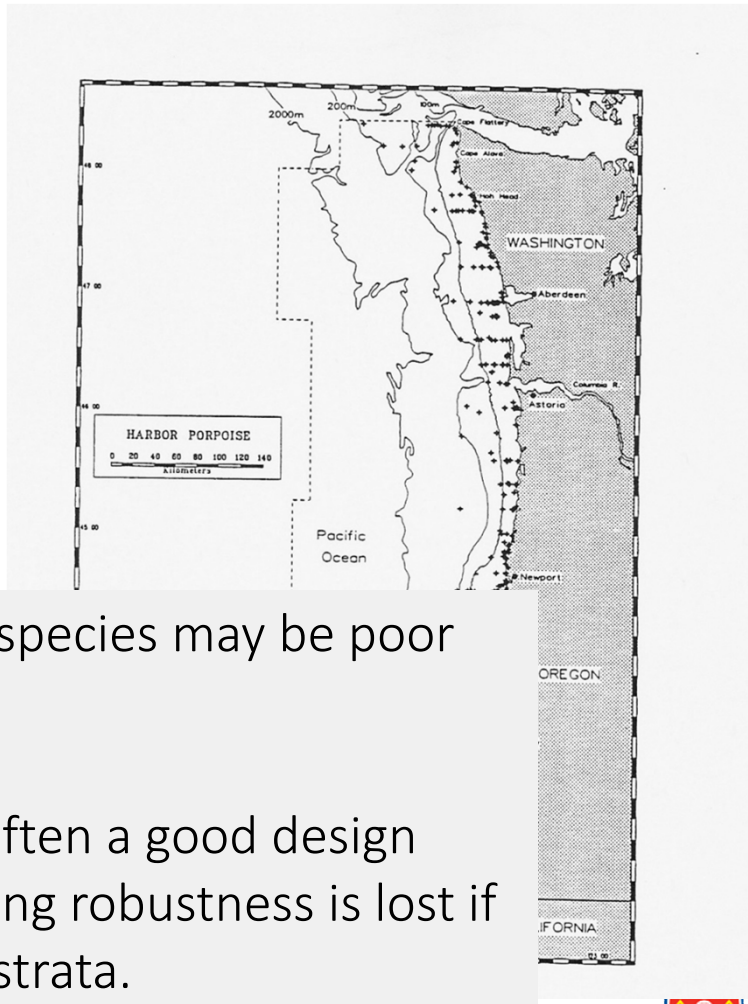


CREEM
Centre for Research into Ecological and Environmental Modelling

University of St Andrews

Stratification (Spatial)





Optimal effort location for one species may be poor for another species.

Uniform effort across strata is often a good design for multi-species surveys. Pooling robustness is lost if coverage differs among spatial strata.

CREEM
Centre for Research into Ecological and Environmental Modelling

University of St Andrews