FWF 410:
“Area, Distance and Plotless Sampling”

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Goal of the Lecture

To familiarize students with area, distance, and plotless sampling designs.

Reading Assignments:

Chap 5: 124-126
  ➢ Line and Point Transects (Distance Sampling)

Chap 20: 530-532
  ➢ Quadrat and Plotless Methods

Handout
  ➢ Point- and Line- Intercepts (different than line and point transects?)

Lecture Structure

I. Area Sampling
II. Distance Sampling
III. Plotless Sampling
Plot (Quadrat) Sampling
Measurement of a habitat component in a square or circular area.

Herbaceous Understory
Woods Under., Mid-, Over-story

RV
Density
% Cover
Presence

1-m² Plot
Circle Easier and Shorter Circumference (no edge) to Make Inclusion Determination

Vs.

40-, 100-, 400-m² Plot
No Consistent Recommendation Exists Habitat Use of Organism (Animal’s Perspective)

Strip (Belt) Transects
Measurement of a habitat component in an elongated plot along or across the gradient of population or species distribution.

a) Across Patches
Location of Individuals and Relative Densities Clustered or Not?

Efficiency
(1) 2 x 500 m transect
(10) 10 x 10 m plots
Assumption: All organisms in strip are detected

Population Gradient

Within Patches
Population Density, Demographic Composition, Occurrence

Low Sample Size
n = 1
n = 10
Example: ferns vs. eagles

Line Transects
Distance Sampling

Assumptions
• All individuals on the transect are detected
• Organisms recorded at their initial location
• Distance measured accurately

Finding 1 Distance

Straight-line Distance to Individual(s) Angle to Individual(s)

Example

Suppose, t = 32 m
θ = 15°

\[ d = \left( \frac{32}{\sin(15°)} \right) = 8.28 \text{ m} \]
**Point Counts**

Distance Sampling

- Can Use Distances or Plots (Assume 100% Detection at center)
- Play Recorder in Practice

**Assumptions**
- Initial Location
- Independent Locations
- Distance measured accurately
- Effects of weather/vegetation on measurements are constant

**Distance Sampling**

Detectability Function

With distance sampling, it is assumed that the detectability of an organism decreases as distance increases from the transect or point.

The rate of decrease in detectability can be modeled with a function, $g(x)$, and depends on environmental variables (vegetation, weather) and the observer.

Generally, distances are truncated at a maximum detectability threshold (50, 75, 100 m).

Density Calculated using $g(x)$ and data

$$ \hat{D} = \frac{1}{2L} \int_0^L g(x) \, dx $$

$L = $ length of transect

Program DISTANCE

http://www.ruwpa.st-and.ac.uk/distance/

90% of observation

**Plotless Methods**

Nearest Individual

Measure Density from the Sample Point to the Closest Individual

Suppose, $d_1 = 6$ m

$$ D = \frac{1}{n} \sum d_i \left( \frac{1}{d_i^2} \right) $$

Indicates,$$ 1 \text{ ind} \approx 278 \text{ ind/ha} $$

$$ \approx 10,000 \text{ ind/ha} $$


Random Distribution

Plug this One Distance into Density Formula

$$ 0.0006 \text{ ha} \times 278 \text{ ind/ha} = 278 \text{ ind/ha} $$

Convert to ha first then $\approx$
Plotless Methods

Point-Centered Quarter

Measure Density

Measure the Distance from the Sample Point to the Closest Individual in each Quadrant

\[ D = \frac{1}{4} \sum_{i=1}^{4} d_i \]

Where \( d_i \) represents the distance from the sample point to the closest individual in each quadrant.

Random Distribution

Average the Distances and Plug into Density Formula

\[ D = \frac{1}{360^\circ} \sum_{i=1}^{360^\circ} \rho \]

Where \( \rho \) is the density of individuals.

Most Commonly Used

Find Individual Closest to Sampling Point

Measure the Distance to its Nearest Neighbor (of the same species)

Suppose, \( d_1 = 6 \text{ m} \)

\[ D = \frac{1}{6} \]

1 ind \( \approx 0.0036 \text{ ha} \)

\[ \approx 278 \text{ ind/ha} \]

Calculations same as Nearest-Individual

Plotless Methods

Random Pairs

Measure Density

• Locate the Nearest Individual to the Sampling Point

• Shoot Azimuth from the Sampling Point to Individual

Random Distribution

• \( +180^\circ \) to Create 180° Exclusion Zone

• Measure distance to nearest neighbor outside of EZ

Calculations same as Nearest-Individual

\[ D = \frac{1}{360^\circ} \sum_{i=1}^{360^\circ} \rho \]

Where \( \rho \) is the density of individuals.
### Plotless Methods

#### Wandering Quarter Distance

- Establish a Transect
- Find First Individual
- Establish a 90° Zone of Selection

\[ D = \sum_{d_i} \text{where } d_i \text{ is the distance to the nearest neighbor in } 90° \]

Original Transect Direction

**Calculations same as Point-Centered Quarter**

### T²-Method

- Establish Random Sampling Points \((n=10)\)
- Measure Distance to Nearest Individual \((x_i)\)
- Measure Distance to Nearest Neighbor \((z_i)\) in 180° Zone of Selection

\[ D = \frac{1}{n} \sum_{i=1}^{n} \left( \frac{z_i}{x_i} \right)^2 \]

\( D \text{ is the same as } \sum_{i=1}^{n} \left( \frac{z_i}{x_i} \right)^2 \text{ per m}^2 \)

### Plot vs. Plotless Methods

Simulations and empirical studies have shown that plot methods are more accurate (unbiased + precise) than plotless methods in estimating population density.

- Point-centered Quarter (overestimated)
- T² Method (underestimated)

Plotless methods are recommended only when individuals are randomly distributed and individual spacing (e.g., >20 m) prevents detection in randomly or systematically placed plots.

**Recommendation:**

- Point-centered Quarter
- T² Method

(trees spaced far apart)