Why?

Examine sampling theory

Concepts learned are applicable to
sampling animal pop'ls., cells, organelles

EcoSampler Virtual Forests

E.g., Wish to Know

• Efficacy of new drugs
• Responses of cells to treatments
• Structure of a natural community
  Can’t examine response of every organism
  However, we can examine a subset that represents the whole
  But that subset must be drawn without bias & in sufficiently large number

Ecologists

Frequently need to know -
  What species compose a community?
  How abundant is each species?
  How do species interact?

Useful to develop -
  Recovery plans for endangered species
  Conservation plans for natural areas
  Understanding of succession

So How Can We Do This?

Issues to Consider?

Sampling methods must enable efficient assessment at reasonable time & cost
Sampling Methods
Method depends on organisms & community
  Secretive animals - "mark & recapture" or "capture per unit effort" methods
  Sessile organisms - "area," "distance," or "line-transect" methods
We will explore:
  1. Area sampling
  2. Distance sampling

Where to Sample?
Three primary approaches:
  1. Haphazard or convenience sampling
  2. Random sampling or stratified-random sampling
  3. Systematic sampling

What's Measured?
Abundance Measures
  Density - # individuals/area
  Dominance - total basal area per unit area
  Frequency - % of samples with given species

What's Measured?
Abundance Measures
  Relative Density - density sp. X as % of total density
  Relative Dominance - basal area sp. X as % of total dominance
  Relative Frequency - frequency sp. X as % of total frequency

What's Measured?
Abundance Measures
  Importance (0 to 300)
    Relative density + relative dominance + relative frequency
  Importance (as a percentage, 0-100%)
    Relative contribution (%) of a species to entire community
      (Importance/3)

What's Measured?
Diversity Measures
  Species richness - # of species in a community
  Evenness or equitability - distribution of individuals among species
  Species diversity - typically, combo richness & evenness
Species Diversity

Reflects Community Structure
Communities w/ high diversity have complex network of trophic pathways
Communities w/ low diversity have fewer species & fewer interactions

Shannon-Wiener Index

\[ H' = - \sum_{i=1}^{S} p_i \ln p_i \]

where: \( p_i = \frac{n_i}{N} \)

- \( n_i \) = Number of individuals of \( i^{th} \) species
- \( N \) = Total number of individuals in sample

Assume two communities, each with 10 species & 100 individuals

Community A
- Sp 1: 10 individuals
- Sp 2: 10 individuals
- Sp 3: 10 individuals
- ...
- Sp 10: 10 individuals
- \( H' = 2.30 \)
- Species richness = 10
- Pielou evenness = 1.0

Community B
- Sp 1: 91 individuals
- Sp 2: 1 individual
- Sp 3: 1 individual
- ...
- Sp 10: 1 individual
- \( H' = 0.50 \)
- Species richness = 10
- Pielou evenness = 0.2

Range of values:
- 0 → a community of only one species
- 3 or less → mixed mesophytic forest of Allegheny Mts.
- 7 or more → rich forests of Siskiyou Mts. of Oregon & California

Dispersion Measure

What's Measured?

Individuals distributed in community as:
1. Random – no relation of one individual to another
2. Uniform – regular spacing, e.g., orchard
3. Clumped – individuals of a given species are aggregated
Spatial Distribution

Dispersion

3 possible arrangements:

- Uniform
- Regular
- Hyperdispersed
- Random
- Aggregated
- Underdispersed

Dispersion

Morisita Index

\[ I_d = n \left( \sum X^2 - N \right) / N(N-1) \]

where: \( n = \# \) quadrats (pts), \( N = \# \) total individuals, \( \sum X^2 = \# \) individuals per quadrat (pts)

Succession:

Temporal Variation

Early successional species to late successional species generate a successional sequence –

Called a Sere (Seral Stages)

1. Primary Succession
   Occurs on a site previously unoccupied by a community

2. Secondary Succession
   Occurs on a site previously occupied by a community

Secondary Succession

Succession often appears directional with a dynamic equilibrium endpoint

e.g., hardwood forest or hemlock forest

Do life-history traits vary along the sere?
Within succession, can we predict the future success of species? Yes, analyze age- or size-class distributions.

Vegetation on Slopes
Type & distribution of trees varies on north-facing vs. south-facing slopes, e.g., West Virginia.

Virtual Forests
Mohn Mill Natural Area
Snyder-Middleswarth Natural Area
What We’ll Do

1. Sample forest communities via haphazard, random, & systematic sampling using area & distance methods
2. Estimate species abundances
3. Examine dispersion, richness, & diversity
4. Determine successional trends
5. See environmental effects on species distributions (e.g., N vs. S-facing slopes)

Assignments

1. Investigate bias in sampling
2. Compare area & distance sampling
3. Explore spatial distribution & succession
4. Examine community attributes - diversity
5. Understand environmental influences on species distributions

Write up – answers to 18 questions

Sampling Theory Using EcoSampler
Warren Abrahamson & Michael Weaver
Bucknell University

http://www.departments.bucknell.edu/biology/courses/core/biol208/index.html