


**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

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**Ecologists** 

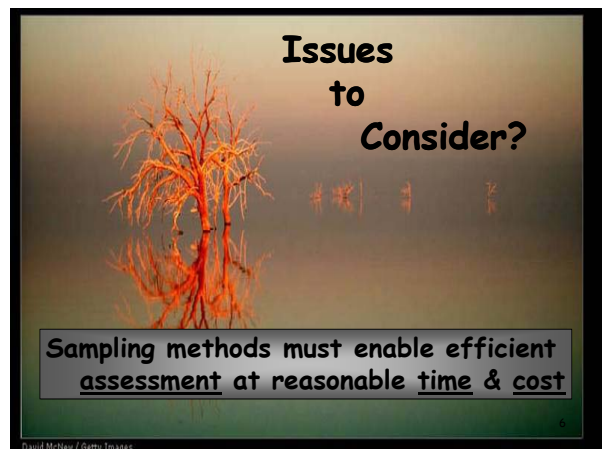
Frequently need to know -

- 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

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## 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

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## Where to Sample?

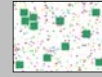


Three primary approaches:

1. Haphazard or convenience sampling

2. Random sampling or stratified-random sampling

3. Systematic sampling



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## What's Measured?



### Abundance Measures

Density -

# individuals/area

Dominance -

total basal area per unit area

Frequency -

% of samples with given species

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## 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

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## 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)

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## 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

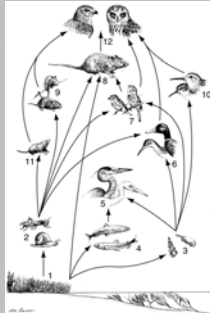
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## Species Diversity

Reflects Community Structure

Communities w/ high diversity have complex network of trophic pathways

Communities w/ low diversity have fewer species & fewer interactions



## Species Diversity



Shannon-Wiener Index

$$H' = - \sum_{\text{species } i=1}^s p_i \ln p_i$$

where :  $p_i = n_i / N$

$n_i$  = Number of individuals of  $i^{\text{th}}$  species  
 $N$  = Total number of individuals in sample

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## Species Diversity



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

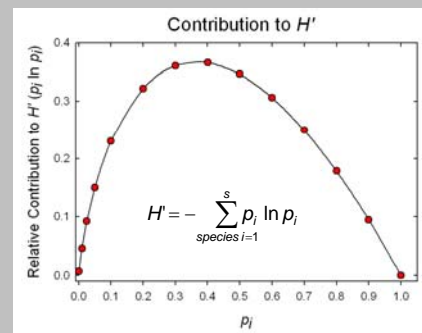
$H' = 0.50$

Species richness = 10

Pielou evenness = 0.2

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## Species Diversity



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## Species Diversity



$$H' = - \sum_{\text{species } i=1}^s p_i \ln p_i$$

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

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## What's Measured?



### Dispersion Measure

Individuals distributed in community as:

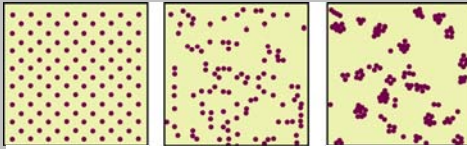
1. Random - no relation of one individual to another
2. Uniform - regular spacing, e.g., orchard
3. Clumped - individuals of a given species are aggregated

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## Spatial Distribution

### Dispersion

3 possible arrangements:



Uniform  
Regular  
Hyperdispersed

Random

Clumped  
Aggregated  
Underdispersed

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## Dispersion

### Morisita Index

$$I_d = n \left( \frac{\sum X^2 - N}{N(N-1)} \right)$$

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

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## Morisita Index

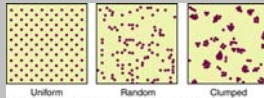
$$I_d = n \left( \frac{\sum X^2 - N}{N(N-1)} \right)$$

Range of values:

$\approx 0$  → uniform dispersion

$\approx 1$  → random dispersion

$\gg 1$  → clumped dispersion



Uniform

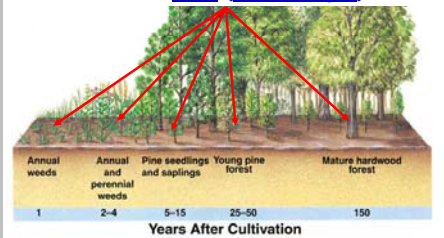
Random

Clumped

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## Succession: Temporal Variation

Early successional species to late successional species generate a successional sequence -  
 Called a **Sere (Seral Stages)**



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## Succession - Temporal Variation

### 1. Primary Succession

Occurs on a site previously unoccupied by a community

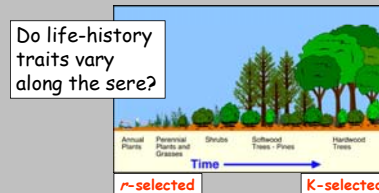
### 2. Secondary Succession

Occurs on a site previously occupied by a community

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## Secondary Succession

Succession often appears directional with a dynamic equilibrium endpoint  
 e.g., hardwood forest or hemlock forest



Succession of an abandoned field in eastern North America 24

## Succession



Within succession, can we predict the future success of species?

Yes, analyze age- or size-class distributions

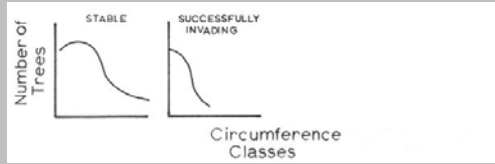


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## Succession



Within succession, can we predict the future success of species?

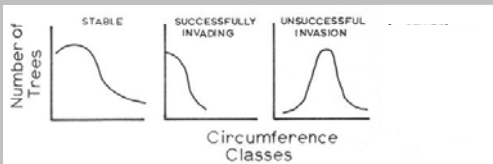


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## Succession



Within succession, can we predict the future success of species?

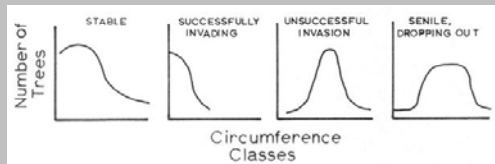


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## Succession

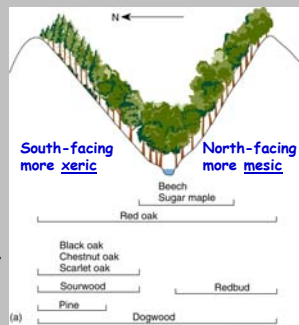


Within succession, can we predict the future success of species?



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## Vegetation on Slopes



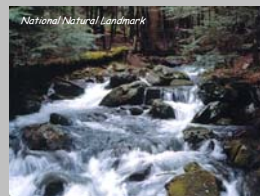
Type & distribution of trees varies on north-facing vs. south-facing slopes, e.g., West Virginia

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## Virtual Forests

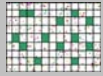


Mohn Mill Natural Area



Snyder-Middleswarth Natural Area

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## 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)

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## 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

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