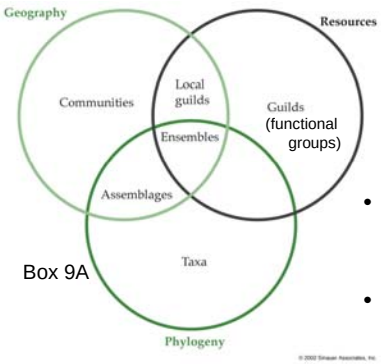
Community Properties

Reading assignment: Chapter 9 in GSF

Describing Plant Communities



Box 9A

- What is a community?
- How are community boundaries defined?

Different views of plant communities

- Clements' "super-organism" concept
  - all species are mutually interdependent
  - these relationships benefited the whole community
    - focused on biotic factors, but acknowledged abiotic factors controlling community development
    - highly predictable trajectory and end points
  - emergent properties

Different views of plant communities

- Gleason's individualistic concept
  - emphasized abiotic and biotic factors, plus chance historical events.
  - individual species have boundaries (tolerance ranges) at different places along environmental gradients
  - within a species' range, chance events determined whether the species is found in a given place
  - in his view, communities were arbitrary human constructs

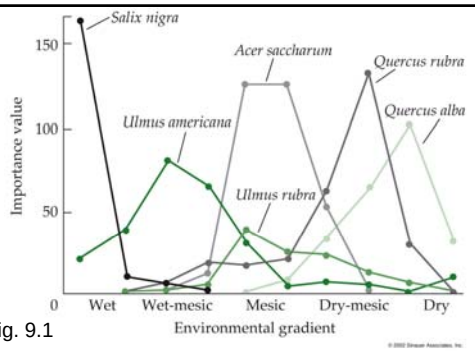
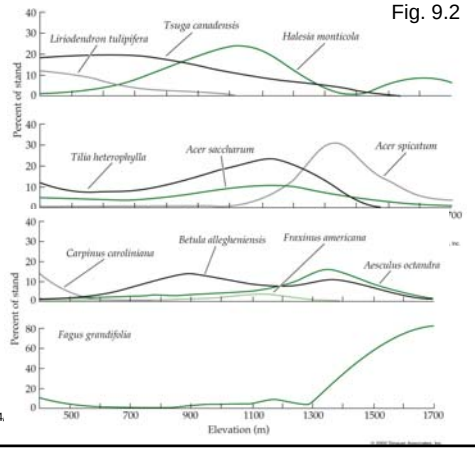


Fig. 9.1

Whittaker's and Curtis' research strongly supported Gleasonian theories, which finally became accepted

Fig. 9.2



Measurable attributes of plant communities

- Physiognomy
- Species composition
- Species distributions
- Species diversity
- Stand structure
- Canopy structure
- Nutrient cycling
- Change over time
- Productivity

Attributes…

- Physiognomy
  - life form (size, life span, woodiness, morphology, leaf traits, location of perennating buds, phenology),
  - vertical structure (height, canopy cover, leaf area index)
  - LAI=total leaf area/ground area
- Species composition
  - Species richness *r* = # species in a community
  - Species evenness is a measure of the distribution of individuals among species
  - Species diversity is species richness weighted by species evenness
  - Species density is # species per unit area

Quantifying species composition

- Cover = percent of ground area covered by a species
  - Basal area is commonly measured in forests
  - Canopy cover is commonly measured in grasslands
- Density = number of individuals per unit area
- Frequency = percent of quadrats in which a species appears
- These values can be relativized so that all species add up to 100%
- Another approach is to combine several relative measures into a single importance value (IV):
  - IV = relative cover + relative density + relative frequency for each species
  - often done in forests

TABLE 9.4 Three different systems for estimating cover by categorizing estimates into a limited number of classes

Braun-Blanquet		Domin-Krajina		Daubenmire	
Class	Cover range	Class	Cover range	Class	Cover range
5	75–100	10	100	6	95–100
4	50–75	9	75–99	5	75–95
3	25–50	8	50–75	4	50–75
2	5–25	7	33–50	3	25–50
1	1–5	6	25–33	2	5–25
+	<1	5	10–25	1	0–5
r	<<1	4	5–10		
		3	1–5		
		2	<1		
		1	<<1		
		+	<<<1		

Source: Mueller-Dombois and Ellenberg 1974.

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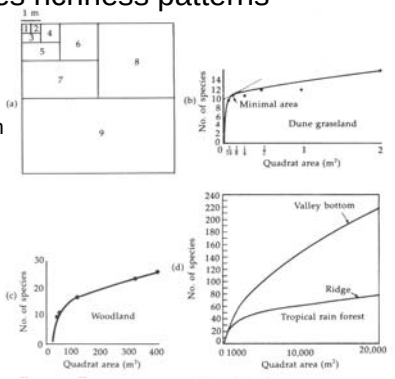
Species-area curves demonstrate species richness patterns

- Species richness increases as the area sampled increases, as shown by a **species-area curve**
- This is a common test to evaluate sampling adequacy



Patterns of species richness

- Species richness is not constant through space. SR (for plants and animals) is negatively related to:
  - latitude
  - altitude
- positively related to:
  - area
  - environmental variability
- and have a complex relationship with:
  - time since disturbance
  - nutrients
  - predation rate
  - productivity
- Islands tend to have low SR

Richness decreases with increasing latitude

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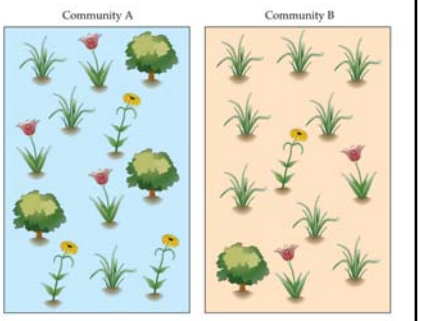
Species evenness

- provides a measure of the relative dominance of individual species
- is most useful when combined into a **diversity index**



Which is more even? Which is more diverse?

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Three scales of biodiversity

(Whittaker 1975)

- Alpha diversity: diversity within a single community
- Beta diversity, change in community composition across an environmental gradient
- Gamma diversity, total diversity across several communities, “landscape-level” diversity

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Indices of alpha diversity

- Shannon-Wiener index: $$H' = -\sum_{i=1}^{s} (p_i \ln p_i)$$
  - where *H'* is "information" of community
  - p_i is the proportion of individuals (or cover) of the *ith* species
  - Assumes individuals were sampled from a very large population, and that all species are represented in sample
  - Requires actually knowing the true number of species
  - This can introduce bias
  - Useful if the goal is to assess the importance of rare species

Indices of alpha diversity (con't)

- Simpson's index: $$L = \sum_{i=1}^{s} p_i^2$$
  - where *L* is index value, *s* is total # species in sample, p_i is proportion of all individuals (or cover) of species *i*.
  - Measures the chance that 2 individuals chosen at random from the same community belong to the same species
  - Can be estimated without sampling bias
  - Sensitive to changes in proportions of common species
  - Not so good for assessing rare species

TABLE 9.3 A comparison of three species diversity measures as applied to six communities, each containing five species

	Community					
	1	2	3	4	5	6
Species A	20	30	40	50	60	960
Species B	20	30	30	20	10	10
Species C	20	20	10	10	10	10
Species D	20	10	10	10	10	10
Species E	20	10	10	10	10	10
Sample size	100	100	100	100	100	1000
Species richness	5	5	5	5	5	5
$e^{H'}$	5	4.50	4.13	3.89	3.41	1.25
D	5	4.17	3.57	3.13	2.50	1.08
J	1	0.93	0.88	0.84	0.76	0.14

Note: The exponential Shannon-Wiener index and the inverse Simpson's index differ in how they change as evenness changes from sample 1 to sample 6. The numbers refer to numbers of individuals, but could also represent biomass.

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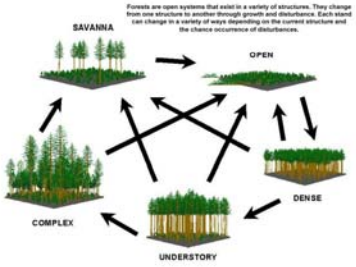
Forest stand structure

- Tree species, sizes and sometimes ages are measured in known areas
- Can be used to estimate timber volumes
- Next week we will learn one way to assess stand structure



http://silvae.cfr.washington.edu/ecosystem-management/images/structure1.jpg

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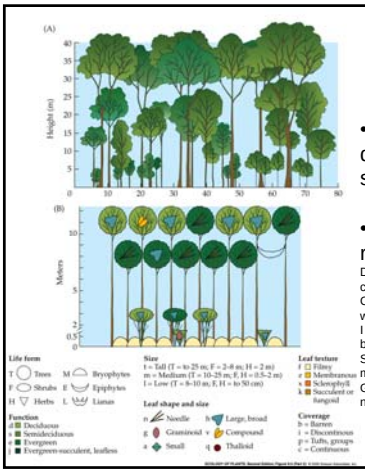

Forest Canopy Structure

- Can provide a view of demographics or potential successional trends
- Canopy classes are recorded, for example:

D - Dominant is 25% or more of the tree crown is above main forest canopy.
C - Codominant is when the tree crown is within main forest canopy.
I - Intermediate is 25% or more of lower crown below main forest canopy.
S - Suppressed is whole crown of tree below main forest canopy.
G – Gap is when the tree has no neighbors nearby its canopy.

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