1. **Lecture summary:**
   - What is a community?
   - Species diversity.
   - Community patterns in space.
     - Classifications.
   - Community patterns in time:
     - Succession.
     - Succession mechanisms.

2. **What is a community?**
   - The community is an assemblage of species populations that occur together in space and time.
   - **Ecological interest is in:**
     - How assemblages of species are distributed.
     - Ways in which interactions among species influence group assembly.
     - Community-level properties of assemblages.

3. **What is a community?**
   - **Collective properties**
     - Include spp. diversity, community biomass & productivity.
   - **Emergent properties**
     - Product of population-level processes:
       - e.g. predation, herbivory, mutualism & parasitism.
     - Not evident from simply summing the interactions.
       - Like limits to similarity of competing species or food web stability when disturbed.
     - Recognition of community patterns has dominated community ecology at different levels of scale.
4. Species diversity:

- Counting numbers of species
- Ideally should be exhaustive
  \( \text{(Fig. 16.3)} \)
- Comparable only if based on similar sampling effort (time or area).
  – Ignores rarity & abundance of individuals within species.

5. Species diversity:

- Simpson’s diversity index:
  – Includes:
    - Number of species (richness), and,
    - Proportion of individuals or biomass that each species contributes to total in the sample (equitability).
      \[ D = \frac{1}{\sum P_i^2} \]
      for \( i = 1 \) to \( S \), where,
      - \( P_i \) is proportion of numbers or biomass contribution by \( i \)th species to the total number of species \( S \) in the community sample (richness).
      - \( \text{Fig 16.4} \) - plots of similar Shannon index & \( \text{Fig. 16.5} \) show full array of \( P \) values ranked for more information on both richness & equitability in rank-abundance diagrams.

6. Community patterns in space:

- Gradient analysis:
  – Distribution of species \( \text{(Fig. 16.6)} \) according to abiotic conditions (overlap in abundances over gradients, not sharp boundaries - also \( \text{Fig. 17.6} \)).
- Ordination of communities:
  – Organization of communities by both species composition and relative abundance \( \text{(Fig. 17.7)} \).
- Classification of communities:
  – Organization by similarity \( \text{(Fig. 17.8)} \).
  – Both ordination and classification are objective and help to understand community associations and perturbations.
7. Community patterns in time - Succession:

- Begon et al., define succession as:
  - "the non-seasonal, directional and continuous pattern of colonization and extinction on a site by species populations."

- Succession describes the process of community change:
  - From colonization of a new habitat (e.g. sandbar, volcanic island, or once Noah found Mt Ararat, etc.) by the "pioneer community."
  - The steady state called a "climax community," in which changes occur continually but they tend to perpetuate the same community structure rather than alter it.

8. Classification of successional sequences within communities:

- **Degradative Succession:**
  - Over short time scales via heterotrophic organisms exploiting dead organic matter (feces, carrion, detritus etc.) until resource completely utilized (Fig. 17.9).

- **Allogenic Succession:**
  - Result of changing, external geophysico-chemical forces which alter conditions (abiotic) such as silt deposition in estuaries and marshes (Fig. 17.10).

- **Autogenic Succession:**
  - Result of internal biological processes which can modify both conditions and resources (biotic). Either:
    - Primary (new habitat, e.g. after glacial retreat - Fig. 17.11), or,
    - Secondary (e.g. old field after agricultural abandonment) (Figs 17.12 & 17.13).

9. Old field secondary autogenic succession:

- Annual < herbaceous < shrubs < early successional trees < late successional trees

- Fugitives, germinate under high light intensity, shade intolerant, r-selected

- Germinate under low light intensity, shade tolerant, K-selected

- See Table 16.3, Fig. 17.15 & Tilman’s resource-ratio hypothesis of succession - Fig. 16.14.
10. Three successional mechanisms:

- Facilitation:
  - Early species make habitat more suitable for new species.
- Tolerance:
  - Different species exploit resources in different ways.
- Inhibition:
  - Invasions resisted by habitat modification
    - e.g. allelopathy.
- see Connell & Slatyer’s overview of successional mechanisms

Figure 16.2: Community hierarchy according to scale.

Figure 16.3: Species richness and number of individuals.
Figure 16.4: Species diversity (H) and equitability (J) of control and fertilized treatment plots in Rothamsted "parkgrass" experiment.

- Control H
- Control J
- Fertilized J

1860 1900 1940

Figure 16.5: Rank abundance plots:
(a, b) theoretical distributions,
(c) effect of fertilizer application on grassland diversity over time.

Figure 16.6: Great Smoky Mountain tree communities
(a) topographical,
(b) graphical with elevation,
(c) tree populations along a moisture gradient.
Figure 17.6 (3rd ed.): Distribution gradients for (a) grasses against pH, and (b) macrofauna across an oyster bed.

Figure 17.7 (3rd ed.): (a) Ordination of Welsh sand dune communities, (b) soil moisture, (c) oxygen diffusion rate, (d) pH, (e) sodium.

Figure 17.8 (3rd ed.): Ordination and classification analysis of 34 invertebrate stream communities in England.
Figure 17.9 (3rd ed.): Temporal and spatial changes in fungal populations of pine needle litter.

Figure 17.10 (3rd ed.): (a) Seawards extension of saltmarsh and (b) vertical plant zonation.

Figure 17.11 (3rd ed.): Plant succession and glacier retreat in Glacier Bay, Alaska.
Figure 17.12 (3rd ed.): Experimental colonization of concrete blocks by marine algae.

Figure 17.13 (3rd ed.): (a) Effects of *Ulva* removal, and (b) harsh conditions, on community structure.

Table 16.3: Physiological characteristics of early- and late-recruited plants. (After Bloom, 1976.)

<table>
<thead>
<tr>
<th>Phenomenon</th>
<th>Early recruited</th>
<th>Late recruited</th>
</tr>
</thead>
<tbody>
<tr>
<td>Seed germination</td>
<td>Good</td>
<td>Poor</td>
</tr>
<tr>
<td>Rooting temperature</td>
<td>High</td>
<td>Low</td>
</tr>
<tr>
<td>High CO₂ concentration</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Light injury intensity</td>
<td>High</td>
<td>Low</td>
</tr>
<tr>
<td>Light compensation</td>
<td>High</td>
<td>Low</td>
</tr>
<tr>
<td>Efficiency of light</td>
<td>High</td>
<td>Low</td>
</tr>
<tr>
<td>Photosynthesis</td>
<td>High</td>
<td>Low</td>
</tr>
<tr>
<td>Transpiration</td>
<td>High</td>
<td>Low</td>
</tr>
<tr>
<td>Mortality and senescence</td>
<td>Low</td>
<td>High</td>
</tr>
<tr>
<td>Resistance to water deficit</td>
<td>Low</td>
<td>High</td>
</tr>
<tr>
<td>Recovery from resource limitation</td>
<td>Two</td>
<td>Three</td>
</tr>
<tr>
<td>Resource acquisition</td>
<td>Two</td>
<td>Three</td>
</tr>
</tbody>
</table>
Figure 17.15
(3rd ed.):
Change in cover by
(a) bare soil,
(b) annuals,
(c) herbaceous
perennials and
(d) woody plants in old
fields. (e) Change in nitrogen
with time.

Figure 16.14: Tilman’s resource-ratio
hypothesis of succession.

Figure 17.16
(3rd ed.):
Three
mechanisms
that underlie
succession.