Species abundance & diversity

Now it gets interesting…

Lecture outline

- Community characteristics
  - Physical structure
  - Biological structure
- Biological structure
  - Abundances
  - Dominance
  - Diversity
- Disturbance
  - Characteristics
  - Intermediate Disturbance Hypothesis
  - A human-caused example

Mt. Rainier NP, Nat. Geo.

What's a community?

- ??
- vs. **assemblage?**
- vs. **guild?**
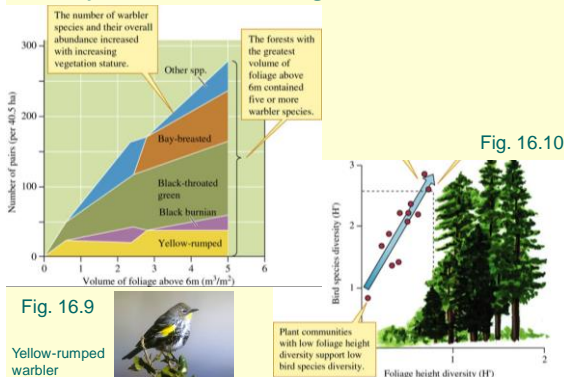- vs. **ecosystem**?

Characterizing communities

- Physical structure
  - Both biotic and abiotic
- Biological structure (=community structure)

"the x-axis"

"the y-axis"

Physical vs. biological structure

The number of warbler species and their overall abundance increased with increasing vegetation stature.

Other spp.

The forests with the greatest volume of foliage above 6m contained five or more warbler species.

Fig. 16.10

Number of pairs (per 40.5 ha)

Bay-breasted

Black-throated green

Black burnian

Yellow-rumped

Volume of foliage above 6m (m³/m²)

Fig. 16.9

Yellow-rumped warbler

Plant communities with low foliage height diversity support low bird species diversity.

Bird species diversity (H')

Foliage height diversity (H')

Biological/Community structure

- **Abundances**
- **Dominance**
- **Diversity**

Abundances

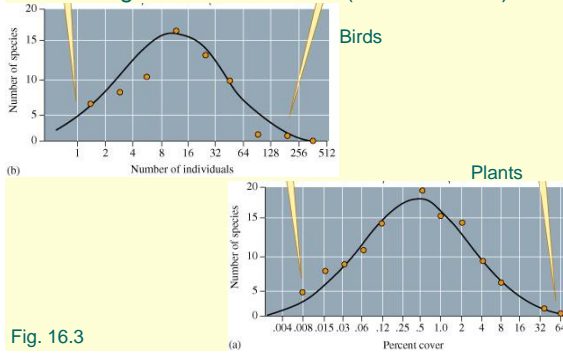- The lognormal distribution (Preston 1948)
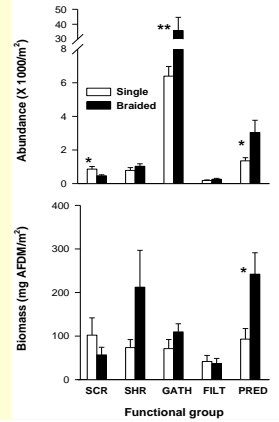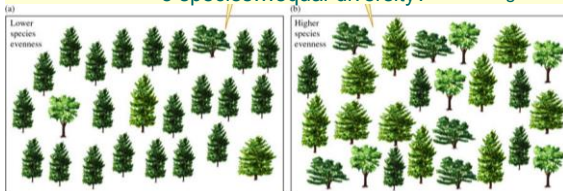
Birds

Plants

Fig. 16.3

Dominance

- How do you tell?
- **Relative abundance**
- **Relative dominance**
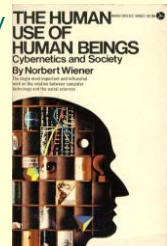- **Importance value**

Diversity

- **Two** components:
  - _____ and _____
- Many formulas to calculate diversity based on these two components, each with varying degrees of success

5 species…equal diversity?   Fig. 16.5

A diversity index

- **Shannon-Wiener Index**:
  - $H' = -\Sigma p_i \log_e p_i$
  - Increases as ? <u>and</u> ? increase
  - Derived from information theory

THE HUMAN USE OF HUMAN BEINGS
Cybernetics and Society
By Norbert Wiener

Claude Shannon
(1916-2001)

Shannon-Wiener Index example

Table 16.1

Calculating species diversity (H′) for two hypothetical communities of forest trees

Community a

Species	Number	Proportion (p_i)	$\log_e p_i$	$p_i \log_e p_i$
1	21	0.84	−0.174	−0.146
2	1	0.04	−3.219	−0.129
3	1	0.04	−3.219	−0.129
4	1	0.04	−3.219	−0.129
5	1	0.04	−3.219	−0.129
Total	25	1.00		−0.662

$$H' = -\sum_{i=1}^{s} p_i \log_e p_i = 0.662$$

Community b

Species	Number	Proportion (p_i)	$\log_e p_i$	$p_i \log_e p_i$
1	5	0.20	−1.609	−0.322
2	5	0.20	−1.609	−0.322
3	5	0.20	−1.609	−0.322
4	5	0.20	−1.609	−0.322
5	5	0.20	−1.609	−0.322
Total	25	1.00		−1.610

$$H' = -\sum_{i=1}^{s} p_i \log_e p_i = 1.610$$

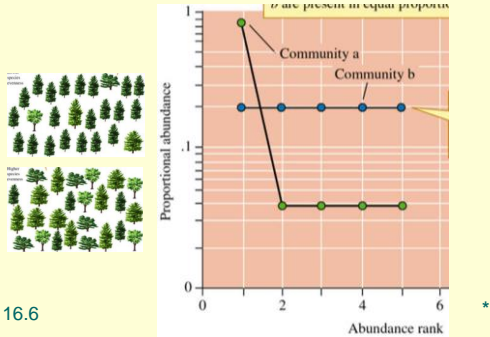## Issues with diversity indices

- H' = 1 here, = 3 there…celebrate or not?
- H' = 3 now, = 2 later…why?
- Also:

A picture of species diversity

- Rank-abundance curves

Fig. 16.6

What controls species diversity?

- Resources?
- Competition?
- Predation?
- Many ecological models assume *stable* environmental conditions—an equilibrium— in order to answer this question
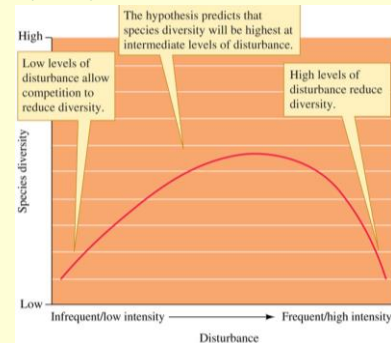- Is this realistic?

Disturbances

- = ?
- Characterized by
  - Intensity
  - Spatial scale
  - Frequency
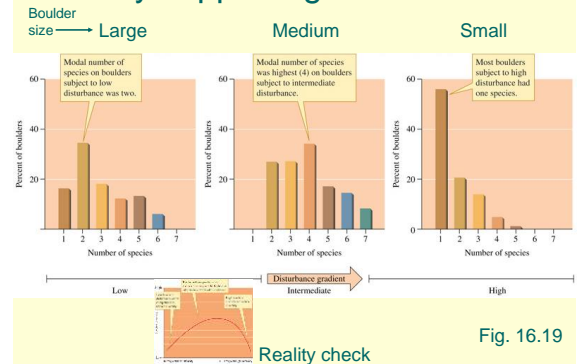 - Duration

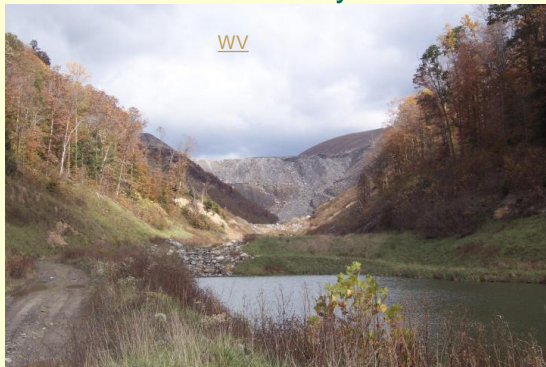## Intermediate disturbance hypothesis

- Connell (1978)

The hypothesis predicts that species diversity will be highest at intermediate levels of disturbance.

Low levels of disturbance allow competition to reduce diversity.

High levels of disturbance reduce diversity.

Fig. 16.18

A test case for disturbance

Any supporting evidence?

Boulder size ⟶ Large   Medium   Small

Modal number of species on boulders subject to low disturbance was two.

Modal number of species was highest (4) on boulders subject to intermediate disturbance.

Most boulders subject to high disturbance had one species.

Low   Intermediate   High

Reality check

Fig. 16.19

A human disturbance example

Mountaintop removal mine in West Virginia
Photograph by Melissa Farlow

Active valley fill

WV

Just how much earth is being moved?

Earth moved by humans

Earth moved by rivers

Hooke (1999)

Figure 1. Maps of the United States showing, by variations in peak height, the rates at which earth is moved in gigatones per annum in a grid cell measuring 1° (latitude and longitude) on a side, by (a) humans, and (b) rivers.
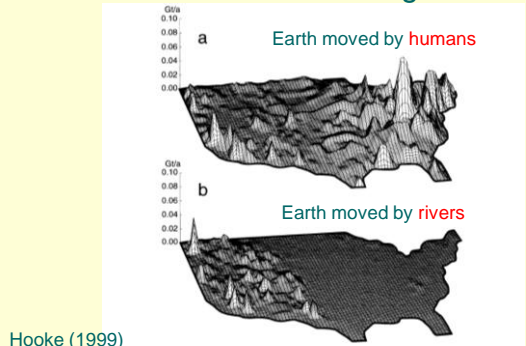
Implications for aquatic life downstream
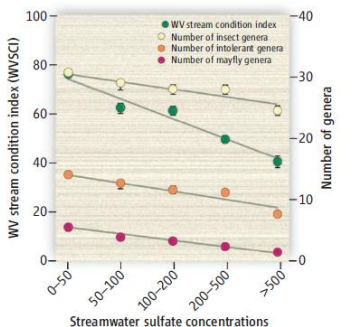
Mining effects on stream chemistry and biota.

Palmer et al. (2010)
Science

Implications for residents

The association between mountaintop mining and birth defects among live births in central Appalachia, 1996–2003

Melissa M. Ahern [a,*], Michael Hendryx [b], Jamison Conley [c], Evan Fedorko [c], Alan Ducatman [b], Keith J. Zullig [b]

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ORIGINAL ARTICLE

Chronic Cardiovascular Disease Mortality in Mountaintop Mining Areas of Central Appalachian States

Laura Esch BS, Michael Hendryx PhD

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RP

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School of Community Health Sciences
University of Nevada, Las Vegas

Poverty and Mortality Disparities in Central Appalachia:
Mountaintop Mining and Environmental Justice

Michael Hendryx, PhD, West Virginia University

Conclusions. Persons living in MTM areas experience persistently elevated poverty and mortality rates. Higher mortality is independently associated with both poverty and MTM, the latter effect suggestive of a possible environmental contribution from mining activities. Efforts to reduce longstanding health disparities in Appalachia must focus on those areas where disparities are concentrated: the Appalachian coalfields.