Basic Concepts for a scientific understanding of how nature works

1. **Scale** – measuring phenomena in time and space

2. **Levels of organization** – the criteria for observation
   - Levels are hierarchically related (but not always cleanly)
   - Levels define the subdisciplines of ecology (but not mutually exclusive)
   - Level reflects both the entity or phenomena of interest and the interests of the observer.

Some of the most exciting ecology tries to make links across levels and across scales.

3. **Data may be quantitative or categorical**

   **Quantitative** – Data that takes on numerical values for which arithmetic makes sense, i.e., may be summed or viewed in ratio to some other measure. May be counted numbers (integers), or measured quantities (real (decimal) numbers).

   **3A. Quantity and number are different.**
   - **Quantity** is the outcome of measurement: Continuous. (think much)
     - Ex: grams of carbon fixed by photosynthesis per square meter per year
   - **Number** is the outcome of counting: Discrete. (think many)
     - Ex: number of species of tree in the forest of the BFEC

   **Changing level of organization often entails converting from number to quantity or vice versa. Use caution.**

   **Categorical** – Data that records membership in some class or group, such as a species, trophic level, or ecosystem class (e.g., *Acer rubra*, insectivore, C3 grassland). May be coded by text or numerically but arithmetic does not make sense.

   **3B. Categorical variables entail a classification hierarchy**
   - Any category is a member of a more general class
     - Ex: taxonomic hierarchy species within genera
     - Ex: BFEC prairie within restored grasslands within terrestrial ecosystems

   **Comparing different classes of phenomena or entities often causes confusion**
   **Different classes may imply different scales or levels of organization**
4. **Positive and Negative Feedback** – may lead to “circular” causality

If A affects B, B affects A: any change in A will *feedback* on A (via changes in B).

**Positive feedback:** increase in generates promotion

**Negative feedback:** increase generates inhibition

Feedback cycles are the basis of much of the *dynamics* of ecological systems. Often impossible to assign “final” cause anywhere in the feedback loop.

**Is there time?: Brief Introduction to Bioclimatology**

**Global Climate Patterns**

Driven by differential solar input and the Earth’s rotation and tilt

*Intertropical Convergence Zone (ITCZ)* –

Near the equator, the Earth’s surface is heated

Air rises and cools, water condenses and falls as rain

Generates:

1) Band of warm rainy climate in the tropics
2) Circulation cells – Hadley Cells

ITCZ moves northward and southward with the seasons

*Circulation cells* – 3 from equator to pole

1. Hadley Cells (~ 0-30 degrees lat)
2. Ferrel Cells (~ 30-60 degrees lat)
3. Polar Cells (~ 60-90 degrees lat)

Jet Streams arise at the cell boundaries

Coriolis effect – because of the Earth’s rotation as the circulation cells move air N-S, winds are deflected E-W with respect to our position on the ground.

These circulation patterns then interact with ocean currents and topographic landforms (next time) to generate global patterns of climate.

**Feedbacks can occur at any level of organization and at any scale.**

Example: Even though biomes are “determined” by patterns of climate (next time and Molles, Ch 2), there is mounting evidence that the Earth’s vegetation feeds back to effect patterns of climate as well.

Zeng et al. (1999, *Science*) were only able to recreate historical precipitation patterns over the West African Sahel when they included truly interactive vegetation in their simulation model.

Cox and others (2000, *Nature*) show that interactively modeled vegetation affects forecasts of future global warming, actually increasing temperatures over the next two centuries.