BI 416/516 Study Guide for Midterm #2

Be ready to relate topics from the literature papers we read to the main concepts discussed below.

Chapter 6 – NPP and NEP

Why is NPP important? What is the difference between biomass and productivity? What are GPP, NPP, NEP, Plant respiration and heterotrophic respiration? How are all these related to one another? What are the major ecosystem carbon pools? What are the major fluxes between those pools? What feedbacks operate between those pools? (All this was also on the previous test, but is relevant to understanding NPP and NEP too).

What are the main controls on NPP? Do they differ at the leaf, plant, and ecosystem levels? What are the components of plant respiration and how might they differ among different plant types (e.g., sun vs. shade)? How is plant allocation important in affecting NPP? How does this relate to responses to different levels of fertility, e.g., as discussed in Funk and Vitousek 2007?

How do temperature, moisture, and AET relate to each other? How do they influence NPP? What do we mean by nutrient limitation? What are the differences between primary limitation, secondary limitation, and co-limitation? Given plant allocation strategies, which do we expect to find most commonly? How does this relate to Liebig's Law of the Minimum? How do climate and soil resources interact to determine NPP? How does nutrient limitation relate to the results of Helfield and Naiman (2001) and the critique by Kirchoff (2002)?

How might different plant species influence NPP? How does this relate to the observed difference between interannual variation in NPP at one place in response to climate variation versus differences across gradients in resource availability? How do these different responses relate to the different plant strategies described in Chapter 8? How do rates of NPP change through successional time?

Why is NEP important? What are the main controls on NEP? How does NEP change through successional time? How do we measure NEP and what assumptions are involved?

Chapter 7 - Decomposition

Why is decomposition important in the global C cycle? In ecosystem C cycles? What happens during decomposition? What are the 3 main steps? Who does them and why? What happens to litter/compounds that are left over? Which compounds decay first and which last?

What is k and how does it relate to the exponential decay equation? How can we calculate k? What assumptions are involved for different methods? What is litter turnover time? What are the primary controls on decomposition and how do they influence k? How does k differ among different major ecosystem types? Among different litter types?

Understand how the different major short-term controls influence decomposition rates, and in turn, how state factors and interactive controls influence the short-term controls. What are some indirect effects of climate (temperature and moisture) and how strong are they relative to direct effects? How does AET affect decomp? How do %lignin, lignin:N, C:N, and %N of litter affect decomposition rates? Why? What happens during immobilization and mineralization phases of decomposition? Why, and how are these phases affected by the above litter quality parameters?

What are some factors that could cause long-term imbalances in decomposition and production in ecosystems?

How do the results of Finzi and Schlesinger (2002) relate to the main controls on decomposition and potential feedbacks from elevated CO_2 to decomposition? Given the differences among species in litter quality observed by Finzi et al. (2002), what are some likely hypotheses about how these species differ in their nutrient use efficiency?

Chapters 15 and 9 – Terrestrial Nutrient cycling

Know the main global pools and fluxes in the nitrogen cycle. Which ones are biotic and which abiotic? Which are larger? What are some consequences of the increased quantities and mobility of nitrogen resulting from human activities? What are the primary nitrogen-containing atmospherically active trace gases and how do they differ in their sources and effects?

What are the main ecosystem pools and fluxes in the nitrogen cycle? What are the main inputs and outputs of nitrogen from an ecosystem? What happens in N-fixation? Who does it? What are the controls on N-fixation at the ecosystem scale? How do the biochemical qualities of the nitrogenase enzyme influence the ecological interactions and controls on N-fixer abundance and activity? What are the 3 main sources of N deposition and how do they vary with both ecosystem type and geographic region (as related to potential sources)?

What are mineralization, nitrification, denitrification, and immobilization? Why are they important to the overall N cycle? What organisms mediate these fluxes? What are the main process controls for each?

Which type of nitrogen-containing molecule is most susceptible to leaching? What are some consequences of leaching for "downstream" ecosystems?

Why is phosphorus cycling important in ecosystems? In which ecosystems does production tend to be limited by P and in which by N? Why? How does P availability change through long-term successional development? How does this differ from N? How does this relate to the results of Wardle et al. (2004) and the response by Kitayama?

Chapter 8 – Plant nutrient use
See also Funk & Vitousek 2007
Focus on the following sections:

1. **Introduction and Overview (176-77)**

a. What are 2 reasons described that plant nutrient uptake is important? Can you think of any others?

2. **Nutrient uptake (180-188)**
    1. What governs nutrient uptake by plants? How does this differ from C cycling?
    2. What plant characteristic is the best predictor of nutrient uptake capacity? Why?
    3. By what mechanism do mycorrhizae affect plant nutrient uptake?
    4. How are mycorrhizae different from and similar to N-fixing mutualisms in terms of
        1. What organisms are involved?
        2. Morphological structures/associations of the organisms involved?
        3. Primary nutrients taken up and sources of those nutrients?
        4. Costs/benefits of the association – who gets what from whom?

    e. How do nutrients get into roots? What does it cost for nitrate vs. ammonium?
    f. What is the Redfield ratio? Is it similar in plants and algae?
    g. How does nutrient stoichiometry influence uptake of resources in addition to the most limiting nutrient?

3. Nutrient use efficiency (190-191)

a. What are the two components of nutrient use efficiency? How do they relate to the basic principle of environmental control and plant responses to nutrient limitation discussed in Chap. 5 (e.g., SLA, photosynthetic capacity)?
b. Under which environmental conditions is it most competitively advantageous to have high NUE vs. low NUE? Why?
c. How does this relate to the results of Funk and Vitousek 2007? What do their results suggest about common generalizations that invaders succeed because of high growth and dispersal rates?

Chapter 11 - Trophic dynamics and secondary production (See also Finlay and Vredenburg 2007)
What is secondary production? What are the main trophic levels in a food chain or food web? In what two main ways are food webs typically simplified? What is a trophic cascade and how does it relate to top-down vs. bottom-up controls on productivity? Why might trophic cascades occur in some ecosystems but not others?
Where does the energy come from that ultimately fuels ecosystems? Why is GPP > NPP > NEP? What is a trophic pyramid? How might such pyramids differ for biomass vs. energy flow (production)? How might they differ for aquatic and terrestrial ecosystems? Why? How does food chain length vary with NPP (both theoretically and in the real world)? How does herbivory affect nutrient cycling in different types of ecosystems?
What are the three main efficiency factors in secondary production? How do they combine to determine overall trophic efficiencies? How do these efficiencies differ for different types of consumers (e.g., small vs. large, homeotherms vs. heterotherms vs. poikilotherms)? For different types of organic matter?
Understand the basic terminology and concepts of stable isotopes (e.g., delta values, fractionation). What do we mean by "You are what you eat" for ^{13}C? How can mixing models help determine relative consumption of different food sources? What situations might complicate the use of mixing models and solutions can (sometimes) help resolve mixing "muddles"? How can ^{15}N be used to help determine trophic position?
How do some of the strengths and limitations of stable isotope methods play into the techniques, assumptions, and simplifications in the Finlay and Vredenburg (2007) study? Can you interpret the isotopic shifts they observed (particularly for *Rana muscosa*) in lakes with and without fish as shown in Fig. 3 and Table 3? By what mechanisms do they posit that fish are influencing frog populations? What supporting evidence do they use to help substantiate their conclusions about these mechanisms? What is the main message of this paper?