Potential Essay questions. You'll have a choice between two of these questions on the exam.

1. Your book argues that LAI and season length are better predictors of NPP across biomes than is the daily photosynthesis rate per unit leaf area. A) Why might this be so, given what we've learned about photosynthetic responses to leaf N, plant responses to increased N availability, and plant allocation strategies? B) On the other hand, Helfield and Naiman (2001) argue that higher leaf nitrogen content (lower C:N ratio, Table 2) is responsible for greater tree growth in salmon spawning versus reference sites. How do you reconcile these two perspectives?

2. Your textbook states that there are two ways for a plant to achieve high resource use efficiency (carbon gain per unit resource acquired). Chapin (1980) argues that plants in different resource environments use one strategy or the other. A) What are the two strategies? Give brief examples of how plants might achieve each. B) Which strategy is important in which type of environment, and why? c) How does this relate to the results shown by Funk and Vitousek (2007) in terms of invader success, below?

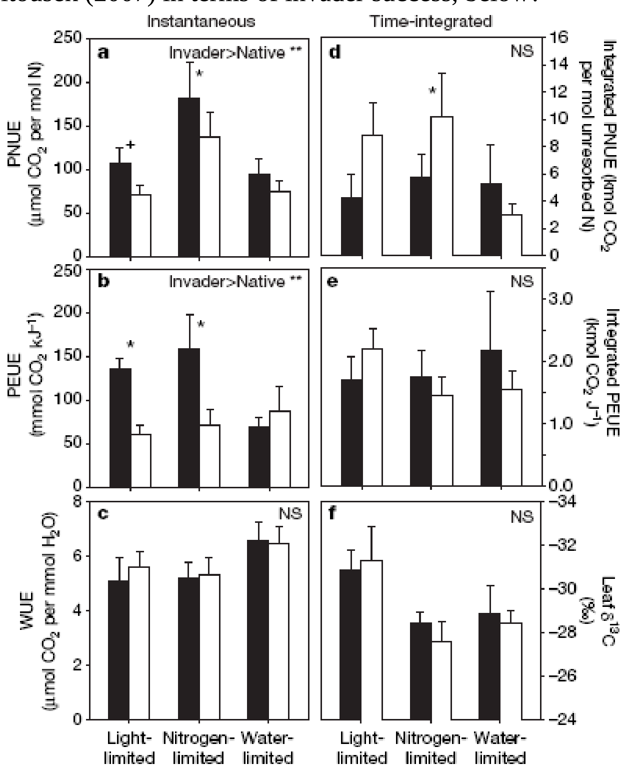

Figure 2 | Instantaneous and time-integrated measures of nitrogen-, energy- and water-use efficiency for phylogenetically related pairs of invasive and native plant species from three habitats in Hawaii.
a, **d**, Photosynthetic nitrogen-use efficiency; **b**, **e**, photosynthetic energy-use efficiency; and **c**, **f**, water-use efficiency. Data and symbols as in Fig. 1 (NS, no significant differences across habitats). Instantaneous PNUE, PEUE and WUE measures include data from 19, 13 and 19 pairs, respectively. Integrated PNUE, PEUE and WUE include data from 12, 13 and 17 pairs, respectively.

3. Given the data shown below (Fig. 3a from Finzi et al. 2002), how do you expect elevated CO_2 to affect total ecosystem decomposition rates, based on its effects on lignin concentration of leaves? Why? Name two other direct or indirect effects of elevated CO_2 that might influence ecosystem decomposition and briefly describe the mechanism.

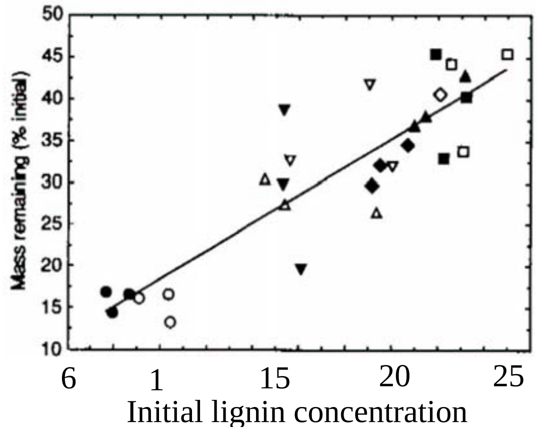

Fig. 3a from Finzi et al. 2002, showing percent of initial mass remaining following 24 months of decomposition for litter of different species. The different symbol styles represent different species, with filled symbols being from ambient CO_2 and dark symbols from elevated CO_2 (3 replicates per species from each treatment).

4. In a study of how lake food webs affect net lake carbon balance (Schindler et al. 1997), the researchers found a strong effect of adding or removing piscivorous fish on whether or not lake ecosystems became a net sink of carbon under phosphorus fertilization (fig. 1). Without fertilization, all lakes were sources of CO_2 to the atmosphere. With piscivores, fertilized lakes remained C sources to the atmosphere, but without them they became carbon sinks. Explain these results in the context of nutrient limitation, trophic cascades, and top-down vs. bottom-up control on NPP. Do you think the results would have been more or less clearcut in more diverse aquatic ecosystems (e.g., fig. 2)? Why or why not?

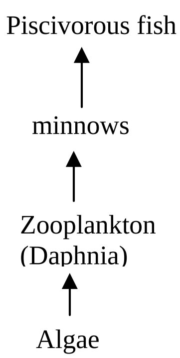

Figure 1

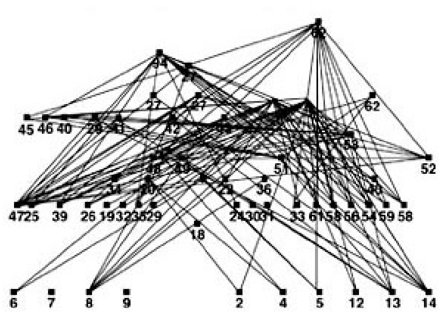

Figure 2

5. For consumers, you are what you eat, isotopically speaking. Salmon returning from the ocean to spawn in streams carry the ^{15}N signal from the marine critters that they've been eating, and this isotopic signature is substantially enriched in ^{15}N relative to most stream invertebrates and terrestrial vegetation that form the base of stream food webs. Helfield and Naiman put forth the hypothesis that after spawning, the salmon carcasses end up fertilizing vegetation near the stream. Below is data for $\delta^{15}N$ and tree stem growth from riparian areas that have large spawning populations of salmon vs. those that don't (reference sites). <u>Critically evaluate</u> (both pros and cons) whether or not <u>these data</u> support the hypothesis of salmon fertilization. For full credit, you must specifically refer to information shown in the graphs below and you must include both supporting evidence and counter evidence/alternative hypotheses.

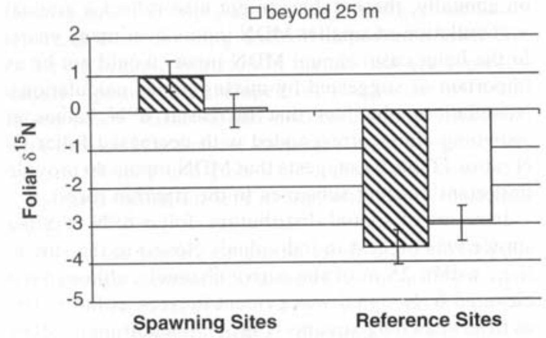

FIG. 1. Mean (± 1 SE) foliar $\delta^{15}N$ in riparian Sitka spruce at spawning and reference sites. Two-factor ANOVA indicates a significant salmon effect (i.e., spawning vs. reference sites, $F_{1,72} > 67.38$, $P < 0.0001$), no significant effect of distance from the stream (i.e., within 25 m vs. beyond 25 m, $F_{1,72} > 0.11$, $P > 0.50$), and no significant interaction effect of salmon and distance ($F_{1,72} > 2.72$, $P = 0.10$).

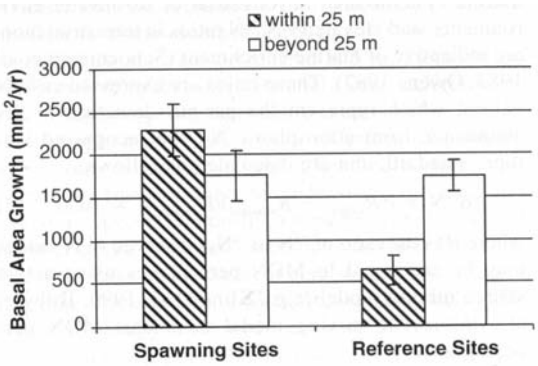

FIG. 2. Annual basal are a growth (mm²/yr) of riparian Sitka spruce at spawning and reference sites. Two-factor ANOVA indicates a significant salmon effect (i.e., spawning vs. reference sites, $F_{1,48} > 6.60$, $P = 0.01$), no significant effect of distance from the stream (i.e., within 25 m vs. beyond 25 m, $F_{1,48} > 0.78$, $P = 0.38$), and a significant interaction effect of salmon and distance ($F_{1,48} > 6.41$, $P = 0.01$). Values are means $\pm$ 1 SE.

Helfield and Naiman 2001