**IB 154 Final Exam Key, Spring 2005**

**Question #1: Explain what a metapopulation is, and describe at least two ways in which relationships between populations in a metapopulation may influence conservation strategies.**
Definition – "A population of populations", or a group of populations with independent dynamics linked *by immigration and emigration* between patches. (Must include acknowledgement of transfer of propagules for full credit). (10pts)

Conservation issues: Several were acceptable (10 pts each)

- Losing one patch decreases the probability of the whole metapopulation surviving
- Sinks can't survive on their own – highlights the importance of the source.
- Sampling only a source or only a sink may overestimate or underestimate (respectively) the viability of the species.
- Partial credit offered for discussion of habitat fragmentation, although these populations are better equipped to survive fragmentation than continuous ones.

Citation: 2 points given for at least one citation: e.g. Levins 1969, Harrison, 1999, Paul Ehrlich, Wolf et al.

**Question #2: Briefly describe two general classes of plant water use strategies presented in lecture.**
This question came straight from Kevin's lecture summary. The two general classes of plant water use strategies discussed in class were 1. Drought avoiders and 2. Drought tolerators. You needed to mention both classes and give a brief description of each class followed with an example discussed in lecture.

Typical strategies associated with drought avoiders include dropping of leaves during periods of drought or dimorphic root system where deep roots tap into area of consistently high water availability. A physiological mechanism employed by drought tolerators is low stomatal conductance. Also some drought tolerators only open their stomates at night, allowing for CO_2 uptake during periods of relatively low atmospheric demand for water.

**Question #3: Explain the nature of the relationship between mycorrhizal fungi and plants.**
A full credit answer included the following:

- the relationship is usually mutualistic
- the interaction takes place at the plant roots [fungi inhabiting leaves are an entirely different matter]
- the fungi receive carbon products produced by the plant during photosynthesis [not $CO_2$]
- the fungi provide nutrients for the plant and/or assist in water uptake, heavy metal tolerance, pathogen protection, etc. [some or all of these were acceptable. Mycorrhizae DO NOT fix nitrogen for the plant]
- the physical connection can occur in different ways (arbuscular mycorrhizae inside the roots vs. ectomycorrhizae with sheath around roots)

- the presence or absence of mycorrhizal fungi can affect plant competitiveness and community diversity (various studies/citations possible here).

**Question #4: Describe two ways in which plants influence the cycling of nutrients in the soil.**

- Plants can have symbiotic relationships with bacteria that fix atmospheric nitrogen, which brings more usable nitrogen into the soil.
- Plants uptake and store nutrients, and therefore prevent nutrients from being leached from the system. For example, in the Hubbard Brook experiment, the watershed lost a lot of nitrate after deforestation.
- Plant leaf litter or waste biomass enters the soil nutrients through decomposition.
- Citing Schlesinger's work on desertification was acceptable if you made a clear argument for the effect on nutrient cycling

Points were lost if you described two facets of the same mechanism, or if your arguments about two separate mechanisms were not clear.

**Question #5: Describe two reasons why the use of climatic averages (e.g. mean annual temperature, mean annual precipitation) are problematic in the prediction of vegetation types across North America.**

You received 15 points for each reason. A complete description included the problem with simply using an average, how this problem affected the vegetation type, and a mention of Stephenson, Whittaker or another relevant author. The two reasons must be distinct.

- *Timing or seasonality* of rain/temperature are not revealed by the mean but affect whether the supply of energy and the need for water occur at the same time during the growing season.
- The *range of variation* around the mean is not reflected in a simple average, yet the extremes in temperature and precipitation will determine whether the vegetation need adaptations for freezing temperatures or drought.

**Question #6: Discuss two reasons why Clements' theories of successional development toward a "climax community" have been criticized.**

Any two of the following were acceptable:

- Clements considered species in a community to be part of a "super-organism," but lots of work shows plant species respond to their environment independently
- Clements' theory assumes a predictable progression through successional stages (like Connell & Slatyer's Facilitation model of succession) but there are other way in which succession can happen (e.g. Connell & Slatyer's inhibition or tolerance model). For example, area freed from receding glaciers went through different successional pathways depending on the nearby plants.
- Disturbance is regular part of many ecosystems, and not just an interruption to succession as in Clements' model.

- Some of what determines species composition has to do with dispersal ability and the chance of landing in an open spot – just because a species can grow in an area, does not mean it will land there to germinate.

Many citations were possible: Davis, Gleason, succession case studies, etc.
The criticism that it is difficult to define a climax community does not mean that Clements may have it wrong. You needed to make a better argument than that.

**Question #7: Diversity/stability experiment.**

a) The hypothesized relationship could be either + or –, but there had to be a mention of the mechanism of how diversity influenced stability.

b) Either experimental (e.g. establish plots with varying diversity) or field-based (using already-established diversity gradients) were acceptable. However, I took off points where it wasn't clear that other variables besides diversity could be controlled. For example, using the latitudinal diversity gradient (tropics vs. boreal forest) would introduce lots of other variables besides just diversity.

   Was there replication ? (-2 if not).

c) Describe what variables were measured as your response variable. Measuring "diversity" or species richness itself wasn't sufficient, since that was part of the initial treatment.

   -5 if resistance was confused with resilience.

d) The criteria to accept/reject the hypothesis must be specifically related to the treatments – e.g. "If biomass was higher in the high diversity treatment, then I would accept my hypothesis that…"

**Question #8: Discuss at least one study that illustrates the central role that disturbances can play in the maintenance of species composition and/or diversity. Make sure you specifically discuss the link between species composition and the disturbance.**
Disturbance was covered many times throughout the semester. Several articles from the reader could have been used to answer this question such as: Wayne Sousa's boulder paper, Tyler (1996) post-fire seedling establishment, Chambers (1995) seed fates in alpine herbfield communities, Connell (1978) the intermediate disturbance hypothesis, Hoobs and Mooney (1991) gopher disturbance in serpentine grasslands. Common concepts discussed in these papers relate to the influence of disturbance on competitive interactions, seedling recruitment, and spatial environmental heterogeneity. We also discussed disturbance from the perspective of early and late successional species and the correlation between disturbance and life-history such as serotonous cones.

**Question #9: What is the source and nature of evidence that industrial activities are changing atmospheric conditions in a way likely to affect the earth's ecosystems? Discuss one piece of evidence that the earth's communities/ecosystems have begun responding to climate change. Are these changes consistent with responses we would expect if climate change were responsible?**

Evidence that industrial activities are changing atmospheric conditions in a way that affects earth's ecosystems comes in the form of increased $CO_2$ as shown by gas samples form Mauna Loa and ice cores. Key point is the absolute rate of change has sky rocketed since the industrial revolution. Evidence observed in flora and fauna include changes in migration patterns, the movement of plant species towards pole and mountain tops along with plant phenology e.g. changes in flowering period and initiation of seed germination. Models have accurately predicted such changes.

**Question #10: Choose one part of the pathway (e.g. Seedbanks, dispersal, germination, etc.) and discuss how ecological interactions at this stage of the pathway can influence plant community composition during succession.**

Many answers were acceptable here. But, they needed to specifically tie a population stage (e.g. dispersal, seedbank, growth) to a mechanism of succession. For example, the presence of a seedbank can influence early colonizers, which is very important in the inhibition and tolerance models of succession. Likewise dispersal. Shading – due to fast growth – was also frequently mentioned in relation to the Tolerance Model.

A citation (such as Howe and Smallwood, or Tyler), needed to be mentioned for full credit.