<u>IB 154 Midterm Key</u>
March 2005

<u>Question 1 – Soil Seedbanks (30 points)</u>
Two ecosystems (5 *pts. each*)

- Acceptable answers included:
    - Deserts
    - Annual dominated ecosystems e.g. annual grasslands
    - Ecosystems with high disturbance frequency, e.g. temperate forests ecosystems or chapparal with relatively high fire frequency
- Dangeorus areas:
    - Definition of dormancy

<u>Question 2 – Life history models "r-selected" and "K-selected" in relation to R-C-S (30 points)</u>
"r" and "K" species characteristics (*5pts. each)*

- Acceptable answers included (*"r-selected"*)
    - Short life-span
    - High reproductive output
    - Early reproductive phase
    - Poor competitors
    - Frequently disturbed habitats
- Acceptable answers included (*"K-selected"*)
    - Delayed reproduction
    - Fewer offspring
    - Long-lived
    - Good competitors
    - Often parental care

Linking R-C-S to "r-selected" and "K-selected" species (*10 pts*.)

- Answers should comment on features of the R-C-S model that were similar to the MacArthur's "r and K-selected" species life history model, e.g. The C and S components of Grimes model added further characterization to species attributes that contribute to long life and few offspring.

<u>Question 3 – Soil nutrient competition (30 points)</u>
Two Strategies *(13 points each)*

- Acceptable answers included:
    - having a lower R* value, (Tilman's Resource Ratio Hypothesis)
    - efficient use of roots to take advantage of places with high nutrient abundance or to quickly respond to pulses of nutrients
    - mycorrhizal associations
    - allelopathy to keep competitors away
    - access unused pools (deep water that competitors cannot reach, take up resource in infrequently accessed form like amino acids)
- Points were subtracted if
    - answer confused the speed at which a resource is taken up with the depletion level of a resource for Resource Ratio Hypothesis. Plant can live happily at a lower level of a nutrient than its competitors, so it wins.
    - Answers were unclear or wrong, or did not address the concept of competition for SOIL NUTRIENTS

Relevant Author *(4 points)*
- Tilman, Stratton, etc.

<u>Question 4 –Evolution of plant defenses (30 points)</u>
How resources influence evolution of defense strategy *(13 points)*
- Benefit of defense must outweigh cost
- Discussion of how resource availability affects the cost of producing or losing a leaf. If the plant loses a leaf, is it a big deal or can it be easily replaced? The reason for either should be linked to the resources.
- Resources determine how much a leaf should be defended (based on how bad it is to lose a leaf and costs over the leaf's lifetime) and what kind of defenses it makes (based on availability and "cost" of the building blocks)

Strategies and species characteristics *(7 points for plants in high resource environment, 7 points for species in low resource environment)*
- In areas of high resources, plants:
  - Grow faster
  - Shorter leaf lifespan
  - Qualitative defenses (alkaloids, etc.) – plant can afford costly maintenance of these chemicals and can move them in and out when needed
  - Leaves are easily replaced because plant grows faster and has more nutrients available to it
- In areas of low resources, plants:
  - Have slower growth rates
  - Longer leaf lifespan
  - Losing a leaf to herbivory is a big loss because they are hard to replace when you grow so slowly and have few nutrients available
  - Invest in quantitative defenses that reduce leaf palatability – expensive at first but then no cost to maintain (and so good for plants that hold their leaves a long time)

Know whose theory this is *(3 points for attributing this to Coley)*
Danger areas (points may be subtracted):
- Confusing leaf lifespan with plant lifespan – you can have long-lived plants (trees, etc.) in areas of low nutrients! Long-lived plants can have short-lived leaves!
- Describing the different strategies does not explain why selection might favor one over the other. Must think about how or why these evolved. If it is "cheap" to produce quantitative defenses, as many people said, then why don't all plants do this?
- Thinking Feeney's apparency model is about resources, and that it says the same things as Coley's model.

<u>Question 5 – Seed Dispersal (55 points)</u>
Pros and cons for three regions = 6 items for discussion *(5 points each)*

	Pro	Con
A	What's good for the parent might be good for the seed or seedling too	Shade from adult Competition with adult for resources Predators/herbivores attracted to adult Pathogen or fungi build up

	Pro	Con
B	Away from parent's shade (maybe: safety in numbers if the predators or herbivores can't eat everyone in the clump)	Too much competition with fellow seedlings Big clump of seeds or seedlings is also attractive to predators High densities let fungi or pathogens build up
C	Little to no competition from your fellow seeds	Land in a bad site (maybe: if you survive, germinate, live a long time, maybe then pollinators might be limited if you're too far away)

Where will the MOST SEEDLINGS survive? *(10 points)*

- INTERMEDIATE distance, somewhere between B & C
- 5 points if you did not say that A or close to the parent were the best spots
- 6 points if you said B or C because you said something about being far away, or some intermediate distance… but this answer isn't correct.

Why does the Escape Hypothesis predict this? *(15 points)*

- You need both a high probability of survival (which increases away from the tree), and enough seeds landing there in order to germinate into seedlings
- For example: Think about 100 seeds falling at 50 m away with a 50% chance of survival. This means 50 seedlings. If you just thought farther is better then you should think about 10 seeds falling 100 m away with 100% chance of survival. This only results in 10 seedlings.
- Good answers also described the main concept of the escape hypothesis as getting away from damaging seed predators or specialized herbivores that are more prevalent near the adult tree on when seeds/seedlings are in high density.

Problem areas:

- Partial credit given for answers about pollinators… this might be true, but there are many life history stages the seed will have to successfully pass through before it can even think about pollinators.
- "Safety in numbers" was ok, especially if discussed in terms of overwhelming what a predator could eat… but had to be distinguished from the more obvious negative effects of high density. Remember, that masting is usually on a landscape scale and NOT just about an individual tree in the forest.

Question 6 –leaf litter and experimental design (55 pts)

Appropriate hypotheses to propose included that litter would *increase* germination (by increasing moisture, most likely), or that litter would *decrease* germination (through reduction of light, resources. Or else, acting as a physical barrier). If only one hypothesis was described, then 10 pts were awarded; if both were described, including the mechanisms, 15pts.

Description of experimental design – 30pts total

- Details of experimental design – 3 treatments (10pts), with standardized conditions (5 pts), and some mention of replication (5pts). Best answers also described how seeds would be added, and whether the experiment took place in the field or in a greenhouse.
- What was the response variable? Germination makes the most sense (10pts). Saying growth or biomass did not receive full credit. That has more to do with seedling dynamics, not seed germination.

What criteria? – 10pts. A statement was required that described "If the % germination was higher in the medium litter treatment than the no litter treatment, then I would conclude that Hypothesis (blah blah) was correct." Or something like that.

<u>Question 7 – matrix models (55pts)</u>
Description of the matrix model – 40pts

1. Define stages of broom life history (5pts). Could be a variety of stages, including seeds, vegetative individuals, flowering adults, or much more complicated ones.
2. Construct transition matrix (10pts). MUST describe some details of how to do this – mark individuals in a cohort and follow their growth/movement/transition into another stage. (Or else -5pts).
3. Count individuals in the population in each stage. = Column matrix (10pts)
4. Multiply Transition and Column matrix. (10pts). For full credit, you needed to make clear that you understood what is multiplied by what. For example, "The number of flowering adults is multiplied by the probability that a flowering adult will produce seeds," followed by a description adding the row of products together to get the next year's projected population size for each stage. Doing this with mathematical symbols was fine, although some people inverted their transition models, so that they described the wrong steps in multiplication.
5. ITERATION (5pts). It was also acceptable to say that Lamda (λ) was calculated to see if the population was increasing or decreasing.

The second part of the question asked you how to use the model to understand how an increase in successful seed production would impact future population sizes. The construction of the matrix alone was not enough. A description of how to modify the matrix model was required (15pts). The most likely way would be to increase the value for "Adult flowers this year producing seeds next year" portion of the Transition Matrix. Then, λ could be compared in the original and simulated matrices.

Did you mention Aplet et al.? If so, a bonus 3 pts up to a possible 55. (But not above).