SAMPLE QUESTIONS: EXAM 3

1. COMMUNITY STRUCTURE (CH 21)
   A long-term experiment testing the effect of fertilizer on species diversity took place in a grassland in England. The results show:
   Control (unfertilized) = no change in Shannon-Wiener Index (H’) from 1860-1940.
   Treatment (fertilized) = decrease in H’ from 2 in 1860 to 0.5 in 1940.
   A. What two components of a community does H’ incorporate?
      1. number of species or species richness
      2. relative abundance (proportion) of each species
   B. What combination of these components yields the greater value of H’?
      High species richness and high evenness in proportion among the species lead to high H’.
   C. Explain the results in terms of competition and niche theory.
      Species in the grassland have some degree of niche overlap and hence potential for competition. The amount of competition depends on resource availability that influences size and number of individuals. Diversity decreased when the addition of fertilizer increased resource availability. With many resources, superior competitors grew large enough to exclude some species so species richness drops. Superior competitors dominate in numbers as well, so there is a low evenness in the community. Thus, H’ drops. In the control, despite niche overlap, little competition is occurring because potentially superior species are not growing large enough to exclude other species.

2. SUCCESSION (CH 22)
   This pattern of succession of species of algae in the rocky intertidal ocean was observed:
   1) Ulva dominated at first and then declined and disappears.
   2) Gigartina entered later and slowly increased as Ulva declined until it was the only species.

   An experiment was conducted in which the early successional species Ulva was manually removed. The results showed:
   Control (no removal) : no change in # Gigartina from Nov-Feb.
   Treatment (removal) : increased in # Gigartina from Nov-Feb.
   A. What is the hypothesis being addressed by this experiment?
      Ulva inhibits Gigartina.
   B. What is the conclusion?
      Because Gigartina density increased sharply when Ulva is removed, we conclude that Ulva inhibits the population growth of Gigartina.

   In another part of the study, 30 plants of each species were tagged and their survival was monitored for 2 months when low tides in the afternoon created harsh physical conditions. The results were:
   Ulva: survival was 20%.
   Gigartina: survival was 90%.
   C. What can be concluded from these results?
      Ulva does not tolerate the harsh physical conditions at low tide.
      Gigartina has high survival under those same conditions.
D. **Summarize what accounts for the succession of species in the rocky intertidal zone.** Ulva rapidly colonizes and inhibits growth of Gigartina. However, Ulva can’t survive long in this harsh environment and dies, eliminating its inhibitory effect on Gigartina. Thus, Gigartina can now expand its population.

3. **ENERGY FLOW in Cedar Lake (CH 6)**

<table>
<thead>
<tr>
<th>Energy production or removal</th>
<th>Energy (kcal m(^{-2}) yr(^{-1}))</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Primary Producers</td>
</tr>
<tr>
<td>Non-consumed production</td>
<td>704</td>
</tr>
<tr>
<td>Removed by consumers</td>
<td>176</td>
</tr>
<tr>
<td>Respiration</td>
<td>234</td>
</tr>
<tr>
<td>Gross production (totals)</td>
<td>1114</td>
</tr>
</tbody>
</table>

A. **Calculate NPP.**

\[
NPP = GPP - \text{Resp} \\
1114-234 = 880 \text{ (or } 704 + 148 + 28 = 880)\]

B. **Calculate Ecological Efficiency (food chain efficiency).**

\[(70 + 31 + 3)/880 = 11.8\%; \ (13/104) = 12.5\]

C. **What ultimately happens to 1) the energy and 2) the biomass that is not consumed in this lake?**

The energy not lost as heat (via respiration) is stored in the unconsumed biomass. The unconsumed biomass likely sinks to the lake bottom where it will either be decomposed, and thus recycled into the food chain, or stored in the sediments on the lake bottom.

4. **NUTRIENT CYCLES (CH 7)**

**Predict 3 ways in which you would expect the pattern of flux and pools of carbon to vary between the tundra and a tropical rainforest. Explain.**

**FLUX.**

1. Annual primary production (GPP or NPP) (or photosynthesis) will decrease from rainforest to tundra. This pattern results from higher rainfall and temperatures, as well as a longer growing season, in rainforest than tundra.

2. Annual respiration (and/or annual decomposition = microbial respiration) will decrease from rainforest to tundra. Respiration increases with higher temperatures; decomposition increases with temperature and moisture, so tropical regions have the highest annual rates of respiration and decomposition.

**POOLS.**

3. Total living plant biomass (stored C) decreases from rainforest to tundra. Large trees dominate in the rainforest, while the treeless arctic tundra has low living biomass. Total soil organic matter (or non-decomposed matter = stored C) increases from rainforest to tundra. Soil organic matter is higher in the tundra because of low decomposition, and lower in the tropics, where rates of decomposition are high due to high temperatures and moisture year round.

5. **NUTRIENT REGENERATION (CH 8)**

Consider this phosphorus (P) budget for a pine forest ecosystem in North Carolina.

<table>
<thead>
<tr>
<th>Process</th>
<th>Amount (kg/ha/yr)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Litter production</td>
<td>35</td>
</tr>
<tr>
<td>Leaching from plants</td>
<td>12</td>
</tr>
</tbody>
</table>
Erosion into streams 20
Decomposition 30
Precipitation 10
Plant uptake 60
Weathering 30

A. Consider the **intersystem cycle**. 
*Which process(es) represent input to his ecosystem?*
1. precipitation  
2. Weathering
*Which process(es) represent output from this ecosystem?*
Erosion into stream  

B. **Using the list above, trace one possible path of a P atom as it passes through the intrasystem cycle. Begin and end the cycle with ‘plant uptake’**.
1. plant uptake → litter production → decomposition → plant uptake  
2. plant uptake → leaching from plants → plant uptake

C. **Why is litter production less than plant uptake?**  
60 – (35+12) = 13 units are unaccounted. Where did they go?
1. Some P was withdrawn from leaves before leaf fall to conserve it.  
2. Some P was retained by the plant and put into plant biomass (e.g. the trunk).  
3. Some P was in leaves eaten by herbivores.  
4. Some P was leached from the leaf.

D. **What would happen to the P budget of this ecosystem if weathering no longer occurred? Explain.**  
The P budget would not be in equilibrium because the output from erosion (20) is greater than the input from precipitation (10). Weathering cannot add the needed 10 units to bring the system into equilibrium.

E. **Is this likely to be a mature forest or a young forest undergoing succession? Explain.**  
This is likely to be a young forest because:
1. its uptake is less than its loss via litterfall/leaching; it is accumulating P and must be in a growth phase.  
2. its loss due to erosion indicates that its soil is not being fully held in place by large root mats of large trees.

6. SPATIAL DYNAMICS/LANDSCAPE ECOLOGY (CH 13+15)
See Figure 15.17 on pg 305 in textbook.
A. **Summarize the two main results. Provide a reason for each result.**  
The populations surveyed in 1956 that went extinct by 1988 had an overall 1) smaller mean population size and 2) were generally a greater distance from another population of the same species in 1956 than the 1956 populations that persisted until 1988.  

**Size** of population is important in persistence of a population because:
a) small populations are more vulnerable to stochastic environmental changes, predation, etc. or  
b) small populations have lower genetic variation than larger populations which may prevent small populations from adapting to environmental changes.

**Distance to nearest population** of the same species is important in persistence of a populations because:
a) smaller distance can allow for immigration to occur from one population to another and prevent extinction from occurring (the rescue effect) or
b) smaller distance can allow gene flow to occur between nearby populations, thereby increasing genetic variation.

B. What are 3 characteristics of a population that enable it to rescue another small population from extinction?
   1. Large size of the rescuing population.
   2. Close proximity to the small population.
   3. Connection to the small population via a corridor
   4. Genetic variation of the rescuing population
   5. Ability to disperse to the small population
   6. Ability to successfully reproduce with the small population
   7. Ability to survive in the new habitat
   8. Have excess individuals to send immigrants to the small population
      (birth rate > death rate)

7. HISTORY/GEOGRAPHICAL ECOLOGY (CH 24)
   See Figure 23.17 on pg 453 in textbook.
   A. Summarize in one sentence the major result in Fig. A.
      An increase in log area of island leads to an increase in log # species.
      Or: There are more species of birds on large islands than small ones.
   B. Summarize in one sentence the major result in Fig. B.
      An increase in distance of island from New Guinea leads to a decrease in # species, (although near islands are also larger than small islands)
      Or: There are more species of birds on islands close to New Guinea than on islands distant from New Guinea (although near islands are also larger than small islands)
   C. What general theory do these results support?
      Equilibrium Theory of Island Biogeography
   D. What are three possible explanations for the pattern in Fig. A.
      1. Greater sample size on large islands causes a greater # species.
      2. Populations are larger and less prone to chance extinction.
      3. Greater habitat diversity in larger areas (more niche space) allows more species to coexist without competitive exclusion.
      4. Larger islands are bigger targets and have a higher probability of being hit by colonizing species.

8. EXTINCTION + CONSERVATION (CH 25)
   You are asked to design a national park system for a tropical country.
   A. What is a ‘hotspot’? Of what use is the concept to your planning?
      A hotspot is an area with many species, including many endemic species, and a high proportion of the species are threatened with extinction. The concept allows me to efficiently narrow the possible choices of area for the park system, and to target areas in which creating of a park will save the most species, including many unique ones.
   B. You have defined your locations. What are 4 principles that you will consider in the next phase: their spatial design?
1. A large area is better than a small area.
2. A single large area is preferable to several small areas of the same total area (SLOSS).
3. Corridors connecting isolated areas are desirable.
4. Compact shapes (like circles) can minimize undesirable edge effects.
C. *What specific attributes of parks are needed to accommodate specific flora or fauna?*
   *Specific habitat requirements of key species, especially keystone species, must be known and accommodated.*
D. *What general criteria related to preserve size must be met to ensure long-term survival of species? (assume habitat requirements are met)*
   1. It must be large enough and provide sufficient resources to support a minimum viable population of the species so that it is unlikely to experience stochastic extinction or any of the other problems affecting small populations (e.g. inbreeding, genetic drift, etc.).
   2. It must include a wide distribution of the species and
   3. some degree of population subdivision to provide insurance against extinction should one portion of the species’ population experience a catastrophe.

9. **GLOBAL ECOLOGY (CH 26)**
   Concentrate on general concepts/principles; not details about each ‘environmental problem’.

Some of you requested a printout of the “SHRUNKEN PLANET”; here it is…why not try it out on your family and friends?

**If we could, at this time, shrink the Earth's population to a village of 100 people, it might look like this:**

* There would be 57 Asians, 21 Europeans, 14 North and South Americans, and 8 Africans.

* 70 would be non-white; 30 white.

* 70 would be non-Christian; 30 Christian.

* 50% of the entire world wealth would be in the hands of 6 people. All 6 would be citizens of the U.S.

* 70 would be unable to read.

* 50 would suffer from malnutrition.

* 80 would live in substandard housing.

* **Only 1 would have a college education.**

--from Fast Company magazine