Worksheet: Species Diversity

1. An ecology student was curious about the effect of a keystone predator on the community structure of a coral reef community. To examine this, the student removed the keystone predator at one location in the reef community and left the other location alone. After a few months, the student sampled each location and plotted the abundance of each species on a rank-abundance curve for each location. The student’s data produced the results at right.

a) What is the species richness at reef location B? 20

b) How does the evenness of reef location A compare to that of reef location B? Explain. The evenness of location A is lower than B because the slope is steeper for A than B.

c) At which reef location (A or B) was the keystone predator most likely removed? Explain. Location A because it has a lower species diversity than location B. A keystone predator functions to increase species diversity in a community by consuming a species at a lower trophic level that would otherwise competitively exclude other species at that lower trophic level.

d) If the student calculated Simpson’s diversity index (1/D) at both reef locations, which would have a higher diversity index? Why? Be sure to explain in terms of the contribution of both richness and evenness. Simpson’s diversity index would be higher at reef location B because it has both higher richness (20 species at location B compared to 10 at location A) and evenness (shallower rank-abundance curve slope) than location A.

2. Why does an increase in total resources or number of added resources commonly lead to declines in species diversity? An increase in resources can cause species diversity in a community to decline because greater levels of resources tend to cause a few species to dominate. At the same time, rare species tend not to be as competitive as the common species and often decline when resources are high.

3. California chaparral is a shrub-dominated vegetation community that is adapted to recurrent fire disturbance. In different regions throughout the geographic range of chaparral, fires occur at different frequencies. Answer the following questions based on the information and data in the table below.

<table>
<thead>
<tr>
<th>Location</th>
<th>Fire return interval (yrs)</th>
<th>Species richness</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ridge</td>
<td>20-30</td>
<td>19</td>
</tr>
<tr>
<td>Slope</td>
<td>50-60</td>
<td>39</td>
</tr>
<tr>
<td>Valley</td>
<td>100-120</td>
<td>24</td>
</tr>
</tbody>
</table>

a. Draw a bar graph that illustrates the relationship between fire return interval and species richness. Be sure to label your axes.
b. Do these results support the intermediate disturbance hypothesis? If so, why? If not, why not? The results support the ID hypothesis because richness appears to be highest at the Slope location, which experiences fire return intervals that are intermediate between the two other sites.

c. Explain the ecological mechanisms that are likely responsible for the observed relationship between fire return interval and species richness. In communities with high fire frequencies (shortest return interval), low species richness tends to occur because most species cannot tolerate highly frequent fires. At low fire frequencies (long return intervals), there is more time between fires; this allows time for species to colonize and eventually fill the available niches. As more niches are filled, species compete more intensely for limited resources. This can lead to dominance by competitive species and a decline in species diversity through competitive exclusion.

4. Referred to as community resilience, ecological communities experiencing a disturbance can bounce back and return to their previous richness, composition and relative abundance.

a. How is community stability measured? What makes this an appropriate measure of stability? Community stability is typically measured as the variability in abundance and/or richness of species in the community. The time frame over which variability is measured depends on the species in the community. In many communities, it is measured as year-to-year variation in abundance or richness. Such measures of variability are appropriate because they provide a quantitative way to assess the ability of a community to maintain a certain structure in terms of species composition, abundance or richness in the face of disturbance, climate change or human-caused changes in or loss of species diversity.

b. In the study by Haddad (2010) [In your textbook], explain how and why the diversity of the plant community increased stability of herbivores, predators and parasites in the prairie. The results of this study indicated that the stability of higher trophic levels (i.e., herbivores, predators and parasitoids) was dependent on the diversity of the basal producer (i.e., plants) trophic level in the food web. Based on their results, higher plant species diversity appears to provide a more consistent availability of food and habitat for the herbivores, predators and parasitoids and that this in turn resulted in more stable communities at higher trophic levels.

5. What is an alternative stable state of a community? Explain how ecological communities can sometimes settle into an alternative stable state. An alternative stable state occurs when a community is disturbed to such an extent that it does not return to the composition and relative abundances of species that present in the original community, and the new community is resistant to further change. This can happen when the disturbance is very large and causes a dramatic change in the prevailing environmental conditions. It can also occur when a keystone species is eliminated. These types of disturbances reset the ecological conditions and can cause a community to settle into a new stable state. Your book provides several examples, both terrestrial and aquatic.