Science Olympiad Ecology Test
Division C

Instructions: Students, in teams of up to two, will complete questions in 50 minutes using nothing other than a non-programmable calculator and their own knowledge. Each question is worth 12-20 points. Please read the questions carefully and follow directions. Good Luck!

1. (15 points) Several types of symbiosis exist in nature, including **parasitism**, **commensalism**, and **mutualism**. Please identify which type of symbiosis exists in the following examples: (some items may be used more than once, bolded organisms are the ones the comparison should be made for)

   - a. A **farmer** in New Zealand uses a **sheepdog** to herd his sheep, and in exchange the animal receives shelter and food.

   - b. Large populations of **humans** exist in cities, and many **rats** also live in cities and consume trash humans produce.

   - c. Gonorrhea, caused by **Neisseria gonorrhoeae**, a bacterium, is a sexually transmitted infection that **humans** contract, with approximately 700,000 persons in the U.S. getting new gonorrheal infections each year, and can cause serious and permanent health problems in men and women (Source: Center for Disease Control).

   - d. Soybeans and other **legumes** often are hosts to populations of **Rhizobium** bacteria that fix nitrogen for themselves and the legumes in exchange for a steady supply of carbon from the plant.

   - e. Between 1845 and 1849, the water mold **Phytophthora infestans** that almost instantly destroyed the primary **potato** crops in Ireland, causing the 1847 Irish Potato Famine and the Highland Potato Famine.
2. (20 points) Given the following list of lake creatures, please construct a food web, filling in the table below by identifying each organism as a **producer; primary, secondary, tertiary, and quaternary consumer; or decomposer.** Please draw arrows to indicate relationships between organisms showing who is eating who, with the end of the arrow (>) pointing at the organism doing the eating.

- *Algae-Use Co$_2$ and light to produce food*
- *Great Blue Heron- eats Juvenile fish*
- *Zooplankton- Eat cyanobactia and algae*
- *Fisherperson- Eats Adult Gamefish*
- *Juvenile Fish-Eat Zooplankton*
- *Cyanobacteria- Use Co$_2$ and light to produce food*
- *Adult Game fish-Eat Juvenile fish*
- *Fungi-eat organic matter in the sediments and dead organisms*

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<tr>
<th>Producers</th>
<th>Decomposers</th>
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<td>4* Consumers</td>
<td>Decomposers</td>
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<tr>
<td>3* Consumers</td>
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<td>1* Consumers</td>
<td>Decomposers</td>
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<tr>
<td>Producers</td>
<td>Decomposers</td>
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3. (12 points) Many organisms have special adaptations to living in an estary. Please **explain what conditions** the bolded adaptations listed in the questions below might be compensating for in one sentence or less.

   a. Pickleweed (*Salicornia sp.* ) is an edible halophytic (salt-loving) plant that tolerates the unique and constantly changing environment of the salt-marsh estuary. Its Latin name *Salicornia* means "salt horns," and describes the shape of the **top sections of the plant that are filled with salt**.
   
   b. Mangrove trees are known for their **roots that grow upward and protrude from the sediment and above the water line**.
   
   c. The smooth cordgrass (*Spartina alterniflora*) found in salt marshes, for example, has **special filters on its roots to remove salts from the water it absorbs. This plant also expels excess salt through its leaves**.

4. (13 points) A survey conducted in one of the hippo's former strongholds, the Virunga National Park in the Democratic Republic of Congo, found that only 1,300 of the animals remain in the area, a drop of 95% in 30 years. That was in 2001. In 2005 the population was down to 800. In this region, poaching is the main cause of population loss. The decline of the Virunga hippo population has also adversely affected the situation of local people, especially the thousands of fishermen living around Lake Edward, within the park. The lake is one of the most productive in the world, as hippo dung provides vital nutrients for fish. The dramatic fall of the hippo population has thus resulted in a rapid decline of the lake's fish stocks.

   a. Most fish don’t eat dung directly. Explain how the nutrients in the dung would be able to get to the fish.
   
   b. Each hippo dumps some 60 pounds (27 kilograms) of dung into Lake Edward every day. Assume each pound of dung contains 1% nitrogen. If ten more hippos are killed, **how many pounds of nitrogen will be unavailable to the fish as dung EACH YEAR?**
   
   c. Assume all 800 hippos are killed. If each would have produced 60 pounds of dung a day at 1% Nitrogen, **how many pounds of nitrogen would have to be provided to make up for the loss of ALL the hippos EACH DAY?**
5. (12 points) White tail deer are very plentiful in Michigan. Their natural predators include cougars, bears, and wolves, as well as bobcats and coyotes to a lesser extent. However, these creatures have become locally extinct in many regions of southwest Michigan, allowing the deer to exceed normal carrying capacities. The DNR has set population goals for southwest lower Michigan at 151,000-186,000, although the actual population in the area is 267,100.
   a. Assuming that the middle of the DNR range is the most likely carrying capacity (168,500 deer), how far above carrying capacity is this population currently?

   b. The DRN thinks that trying to re-establish bears in southwest lower MI might help control the population of deer. However, they need your help determining the number of bears to introduce. Assuming that one bear would eat 65 deer each year, how many bears would you need to reduce the population to the DNR goal?

   c. Well, the DNR was not approved to release bears, and has to address the population issues in a different way. The department decided to use selection by hunters to achieve these goals. Hunting already accounts for 32% of the harvest of deer after 2 years in an MSU study (data shown below). You found how many deer you would need to harvest in part a. Use this information, as well as the total number of deer in the population, to find a percent of the population that is above the carrying capacity. This is the increase in hunting that is necessary. Please add this number to the percent of hunting already achieved to find the new hunting percentage.
Graph for Question 6 showing the relationship between the rates of colonization and extinction and the number of species present in the initial population on islands. Near or far refers to distance to the mainland for colonization. Small or large refers to the size of the island itself.

6. (16 points) Island Biogeography: The graph above shows a graph representing the rate of colonization (left) or extinction (right) on islands as a function of the number of species present. This is shown for islands that are small or large (for extinction), and for islands that are far or near the source population for colonization. For questions a and c, please list the type of island (small or large or near or far, as well as the number of species present)

a. Based on this figure, what types of islands would have the highest rate of colonization?

b. Based on your own knowledge, why do you think this would happen?

c. Based on the graph, what types of islands would have the highest rates of extinction?

d. Based on your own knowledge, why do you think this would happen?
7. (12 points) Scientists have noticed that there is a change in the age at which women are reaching puberty in the United States in the last 50 years. The largest study to date to determine the incidence of precocious puberty in the United States was published by Marcia Herman-Giddens in the journal Pediatrics in 1997, and with a sample size of 17,000 showed that one in every seven Caucasian girls and one out of every two African-American girls develop breasts or pubic hair before the age of eight. In his book "Diet for a New America," John Robbins cites data showing the change in the age of puberty for Japanese girls from 16.5 years in 1875 to 12.2 years in 1974. This life history trait is heritable, though it does respond to environmental cues such as chemicals in the environment and in food that is consumed. There are many claims that say a switch to a more animal-based diet (with more hormones) is the cause of the change.
   a. How would you test such a claim?

   b. Researchers at Clark Atlanta University in Georgia have found links between increased meat consumption and decreased age of puberty onset. Based on this information, what kind of predictions would you make about the age of puberty onset for populations that are currently switching to a more meat based diet?

   c. If meat consumption does decrease the age at which women are reaching puberty, then what sort of consequences could this have for population growth?