**Investigation 16--Eating at a Lower Trophic Level (revised from Molnar)**

**Purpose:**

* Calculate and compare human food needs at different trophic levels, using the data to construct biomass pyramid
* Analyze the benefits and drawbacks of eating at lower trophic levels on a global scale

**Background:**

 A **trophic level**, or feeding level, is made up of all the organisms whose energy source is the same number of consumption steps from the sun in a given ecosystem. The trophic level of plants or producers is 1, while that of herbivores is 2, and that of animals that eat herbivores 3. Higher trophic levels can exist for animals even higher on the food chain. In this exercise you will compute numerical values for human energy needs based on diets at different trophic levels.

**Problem:**

 The owner of a soybean farm raises guinea hens for food and insect and control. Guinea hens will eat grasshoppers and other insect pests and ticks. They also act as a “watchdog” by making g a lot of noise when intruders approach their territory. The farmer allows the hens free range in his fields during the day and provides roosts for them at night.

**For purposes of the following exercises, you may make these assumptions:**

 The farmer lives on 1 hen/day for a year

 1 hen eats 25 grasshoppers/day

 1,000 grasshoppers have mass of 1 kg

 1 grasshopper requires about 30 g of soy/year

 1 human requires about 600 grasshoppers/day

 Dry soybeans have about 3.3 cal/g

**Solve the following problems. Show ALL of your math, including proper units. Some of your answers may be used in calculations for later questions.**

1. How many grasshoppers does one hen eat in a year?
2. How many grasshoppers are eaten by all of the hens that the farmer lives on in one year?
3. What is the total mass (in kilograms) of the grasshoppers eaten by all of the hens that the farmer lives on for one year?
4. How many kilograms of soybeans are needed to feed all the grasshoppers (eaten by all of the hens that the farmer lives on) for one year?
5. Estimates of early Native American hunter-gather societies indicate that a person could collect about 90 kg of grasshoppers per hour, when they are abundant. Now suppose the farmer chose to eat grasshoppers instead of the hens. How many people could the grasshoppers (caught in 1 hour) feed, compared to the one person that the hen fed?
6. How many people could the grasshoppers (caught in 1 day) feed, compared to the one person that the hen fed?
7. How many people could the grasshoppers (caught in 1 year) feed, compared to the one person that the hen fed?
8. The farmer needs to consume 3,000 cal/day. How many kilograms of soy would it take to feed the farmer (for a day) if he ate only soybeans?
9. If the farmer ate only soybeans instead of hens or the grasshoppers, how many people would his soybean crop (from # 4) feed (for a day)?
10. Draw a (generalized) **biomass pyramid** using the data you have developed to the point. (Numbers are not required.)
11. Why do most food chains not have a fourth and/or fifth trophic level?
12. Should people generally eat at a lower trophic level? It seems, by a simple analysis, that the Earth could support many more people if we all ate at a lower trophic level. Outline three pros and three cons of such a practice.
13. On average, cows produce 19 kg of protein/acre/year and soy produces 200 kg of protein/acre/year. Relate these data to the fact that people in less-developed countries usually eat at lower trophic levels than those in developed countries.
14. How does the fact that omnivores, such as coyotes, rats, and humans can eat at many trophic levels contribute to their success?
15. List foods that you would normally eat throughout an entire day.
16. For each food, indicate which trophic level the food came from.
17. Estimate what percentage of the mass of the food you normally eat comes from the first and second trophic levels.
18. What percentage of the mass of the food you normally eat comes from higher trophic levels?
19. Why do you think this is the case?
20. Large predatory fish usually exist at the third or fourth trophic level. Explain why it may not be a good idea to eat these fish often, if at all.