Net Primary Productivity and Energy Flow
Ecosystems
APES
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PART I: NPP
Directions: Complete the following table by calculating the global NPP for each of the ecosystems listed. Calculators may not be used for this assignment. Please show all your work, including units. Display all answers using scientific notation. Arrange the ecosystems from least productive to most productive based on global NPP and then by NPP. Are these tables identical? If not, please explain why.

Ecosystem	Area (million km^2)	Mean NPP per unit area ($g/m^2/yr$)	Global NPP (billion metric tons/yr)	Global NPP (metric tons/yr)
Algal beds and reefs	0.6	2,500		
Boreal forest	12.0	800		
Continental shelf	26.6	360		
Cultivated land	14.0	650		
Desert shrub	18.0	90		
Estuaries	1.4	1,500		
Extreme desert, rock, sand, and ice	24.0	3		
Lake and stream	2.0	250		
Open ocean	332.0	125		
Savannah	15.0	900		
Swamp and marsh	2.0	2,000		
Temperate deciduous forest	7.0	1,200		
Temperate evergreen forest	5.0	1,300		
Temperate grassland	9.0	600		
Tropical rainforest	17.0	2,200		
Tundra and alpine meadow	8.0	140		

Part II: Energy Flow

Methods of investigating energy flow through an ecosystem include examining a pyramid of numbers, of energy, or of biomass. Due to respiration and the second law of thermodynamics, 100 percent of the energy is never passed from one trophic level to the next. The amount of usable energy passed, as biomass, from one level to the next is dependent on the efficiency of the organisms. The idea of trophic levels and energy flow through those levels was first proposed by Lindemann in 1942. The average ecological efficiency between trophic levels is about 10 percent, but it can vary from 2 percent to 40 percent, while plants have a photosynthetic efficiency of 1 to 3 percent.

In this activity, you will calculate the amount of energy passed from one trophic level to the next based on the ecological efficiencies of the organisms. Additionally, you will examine the concept of biomagnification.

The information in the following table represents the energy flow in a hypothetical spring in Florida. Unfortunately, the spring experienced a DDT spill. The concentration of DDT found in the organisms at each trophic level is also given in the table below.

TABLE 1: ENERGY FLOW AND DDT CONCENTRATIONS FOR THE OKEECHOBEE SPRING IN OKEECHOBEE, FLORIDA

Tropic Level	Productivity (kcal/m^2/yr)	DDT present (ppm)
Producers	9,000	0.04
Primary Consumers (herbivores)	1,500	0.23
Secondary Consumers (carnivores)	120	2.07
Tertiary Consumers (top carnivores)	12	13.8

1. Calculate the efficiency of energy transfer from:
    a) Producers to primary consumers
    b) Primary consumers to secondary consumers
    c) Secondary consumers to tertiary consumers
2. What percent of the energy from the producers is transferred to the tertiary consumers?
3. The concentration of DDT in the water was 1.0 X 10-8 mg/L.
    a) How many times more concentrated is the DDT in the producers as compared to the water?
    b) Calculate the ratios of DDT between trophic levels, as it accumulates from producers to primary consumers, primary consumers to secondary consumers, and secondary consumers to tertiary consumers.