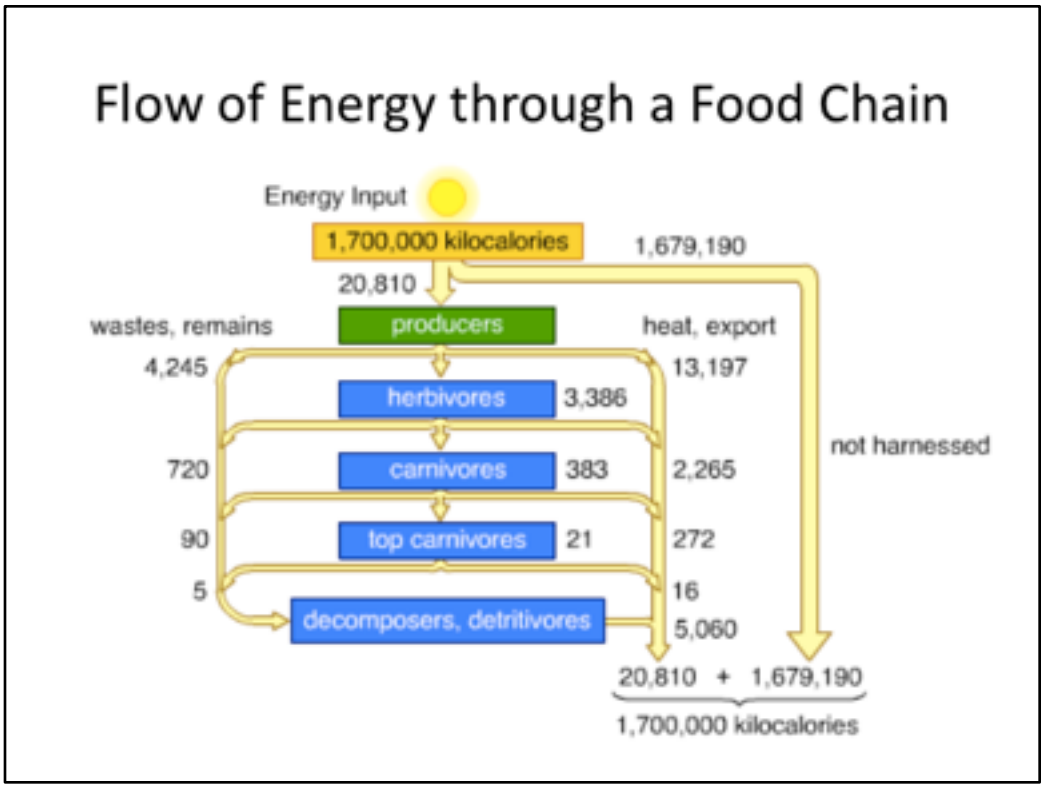
Food Chains/Webs & Energy

- **Autotrophs** – **producers** of food; either photosynthesis or chemosynthesis
  - Photosynthetic autotrophs
  - chemosynthetic autotrophs
- **Heterotrophs** – consume food
  - **Primary consumers** – **herbivores**; feed on autotrophs
  - **Secondary consumers** – **carnivores**; feed on primary consumers
  - **Tertiary consumers** (or higher) – feed on other carnivores
  - Quaternary, Quinary, Senary, Septenary
- **Trophic Level** – position in a food chain

Food Web vs Food Chain

Grass →	Grasshopper →	Toad →	Snake →	Hawk →	Bacteria of decay
In general,					
Autotrophs (Producers) →	Herbivores (Primary Consumers) →	Carnivores (Secondary, tertiary, etc. consumers) →			Decomposers



H. T. Odum analyzed the flow of energy through a river ecosystem in Silver Springs, Florida. His findings are shown here. The figures are given in **kilocalories per square meter per year** (**kcal/m²/yr**). At each trophic level,

Net production is only a fraction of gross production because the organisms must expend energy to stay alive. Note that the difference between gross and net production is greater for animals than for the producers — reflecting their greater activity.

Much of the energy stored in net production was lost to the system by decay being carried downstream

Note the substantial losses in net production as energy passes from one trophic level to the next.
The ratio of net production at one level to net production at the next higher level is called the **conversion efficiency**. Here it varied from 17% from producers to primary consumers (1478/8833) to 4.5% from primary to secondary consumers (67/1478).
From similar studies in other ecosystems, we can take 10% as the average conversion efficiency from producers to primary consumers.
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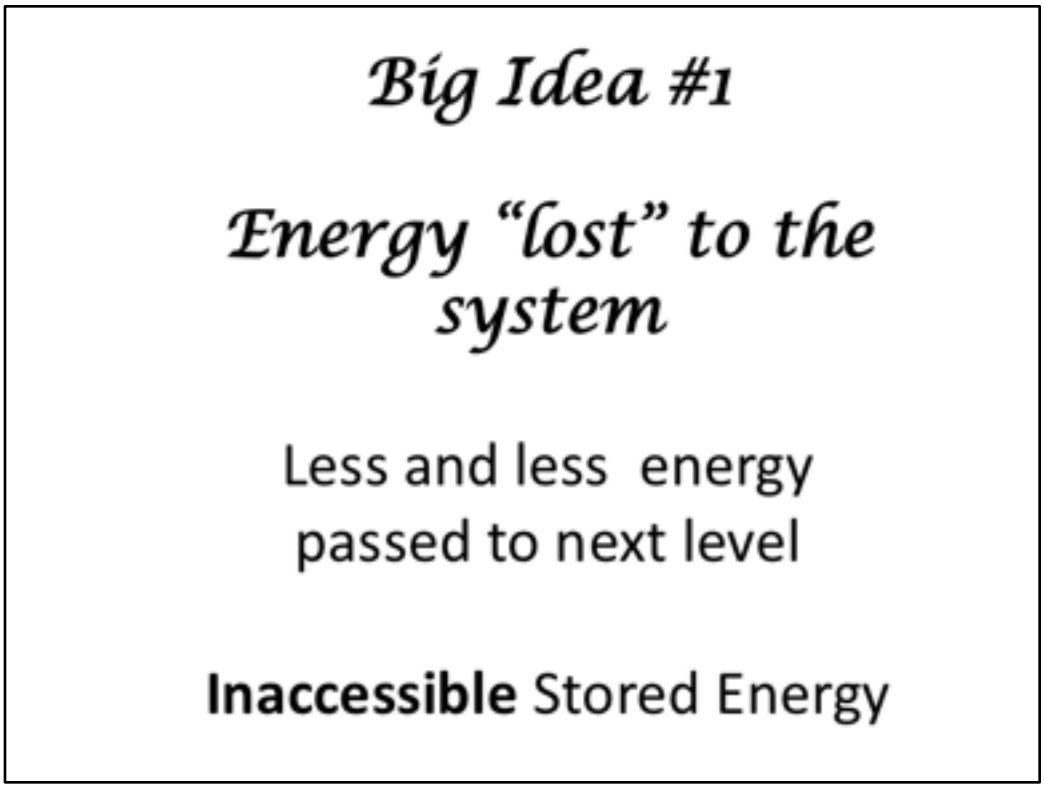
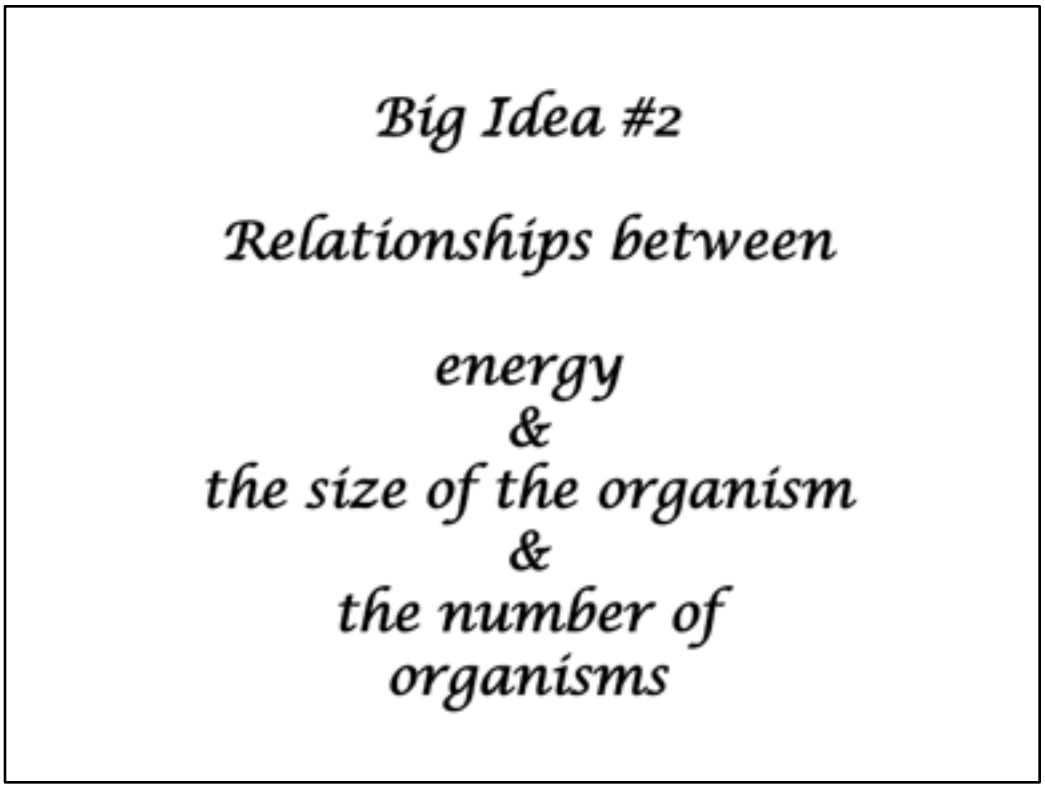
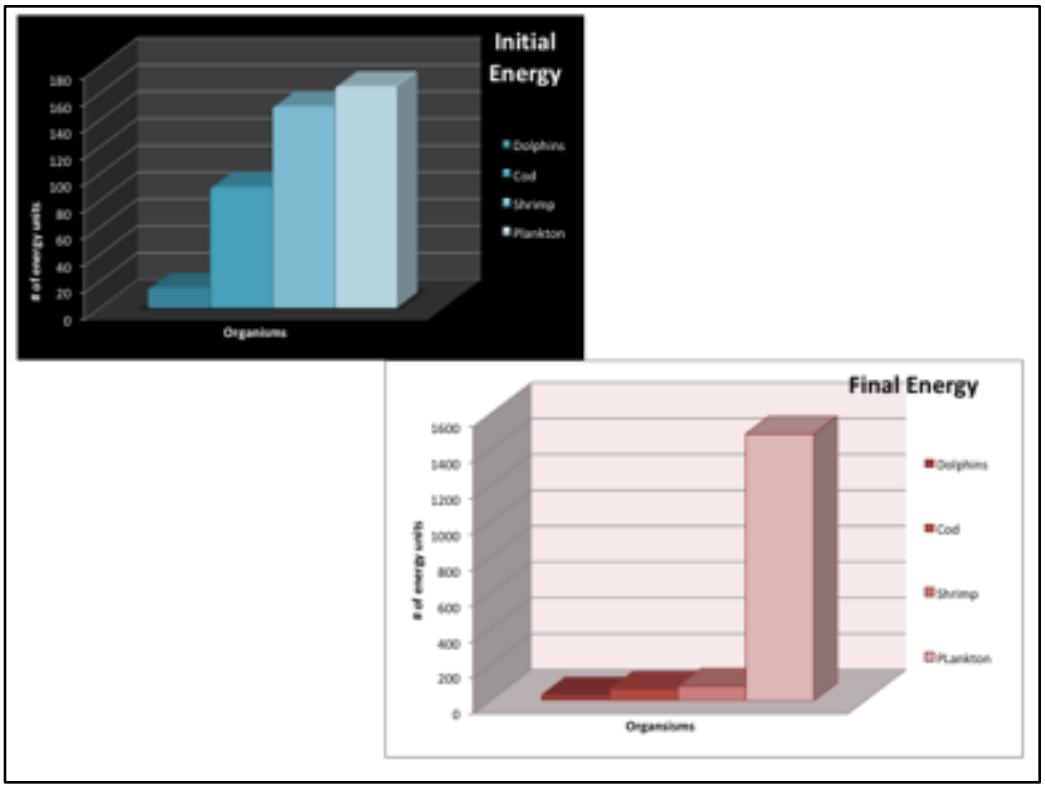


Very little of energy of each organism is passed onto the eater organism.

Energy is "lost", stored in a way that it can not be accessed. At each link in a food chain, a substantial portion of the sun's energy — originally trapped by a photosynthesizing autotroph — is dissipated back to the environment (ultimately as heat).

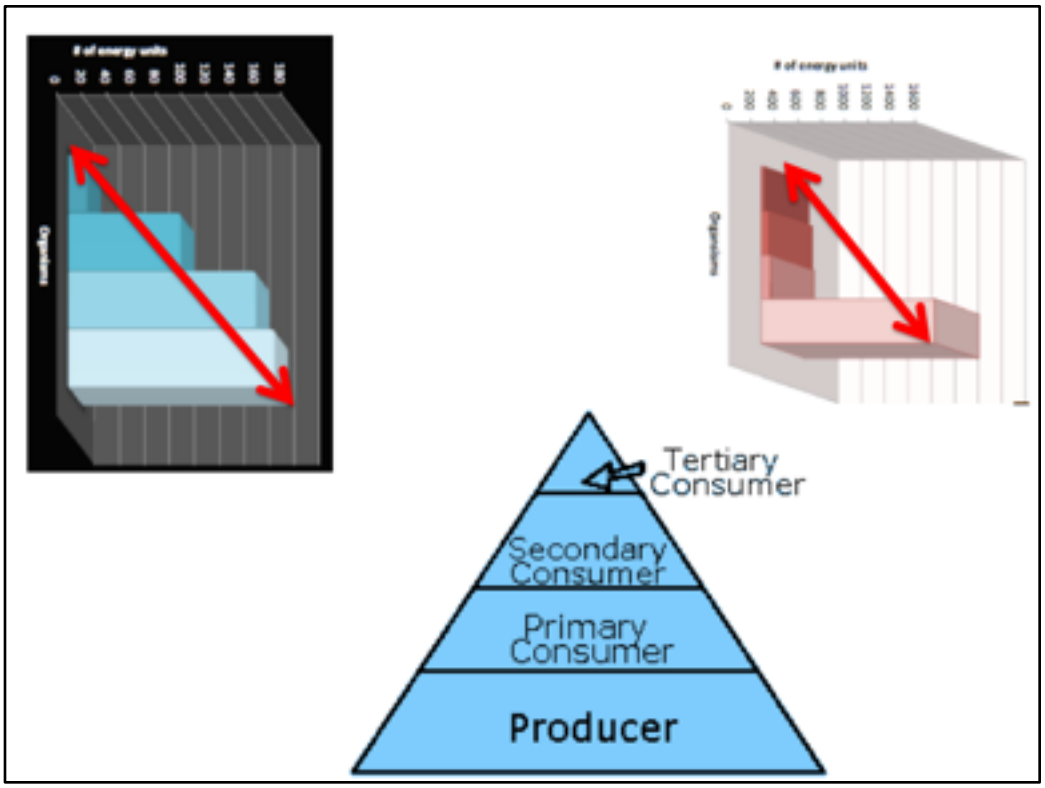


The smaller the organism, the more of that organism in numbers and the more energy present



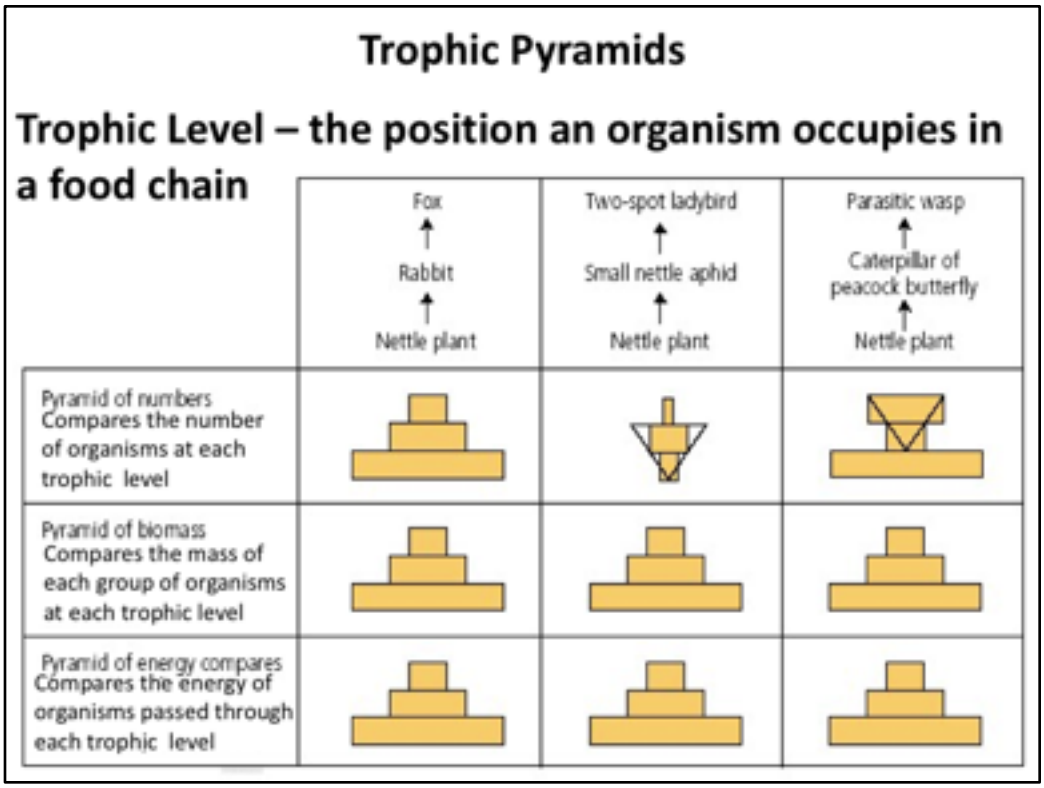
Example of a food chain

What trend do you see in both graphs?



What geometric shape? Right angle → triangle

This decrease in the total available energy at each higher trophic level is called the **pyramid of energy.**



Pyramid of numbers - Small animals are more numerous than larger ones.
The pyramid arises because;

Each species is limited in its total biomass by its trophic level. So, if the size of the individuals at a given trophic level is small, their numbers can be large and vice versa.

Predators are usually larger than their prey.

Occupying a higher trophic level, their biomass must be smaller.

Hence, the number of individuals in the predator population is much smaller than that in the prey population.

Pyramid of biomass - How does one measure the amount of energy in a population? Since all organisms are made of roughly the same organic molecules in similar proportions, a measure of their dry weight is a rough measure of the energy they contain. A census of the population, multiplied by the weight of an average individual in it, gives an estimate of the weight of the population. This is called the **biomass (or standing crop). This, too, diminishes with the distance along the food chain from the autotrophs which make the organic molecules in the first place.**

Pyramid of energy - This decrease in the total available energy at each higher trophic level is called the **pyramid of energy.**
Conversions efficiencies are always much less than 100%. At each link in a food chain, a substantial portion of the sun's energy — originally trapped by a photosynthesizing autotroph — is dissipated back to the environment (ultimately as heat).

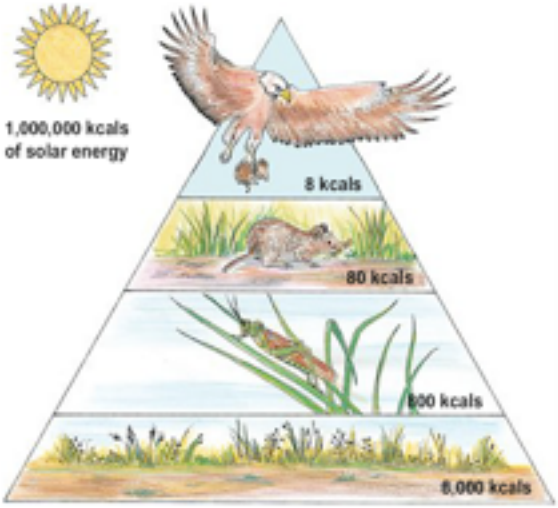
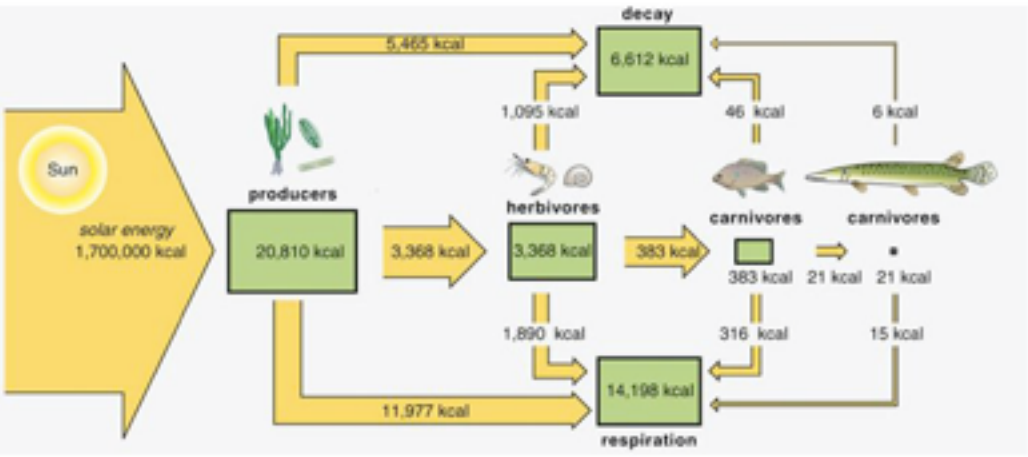
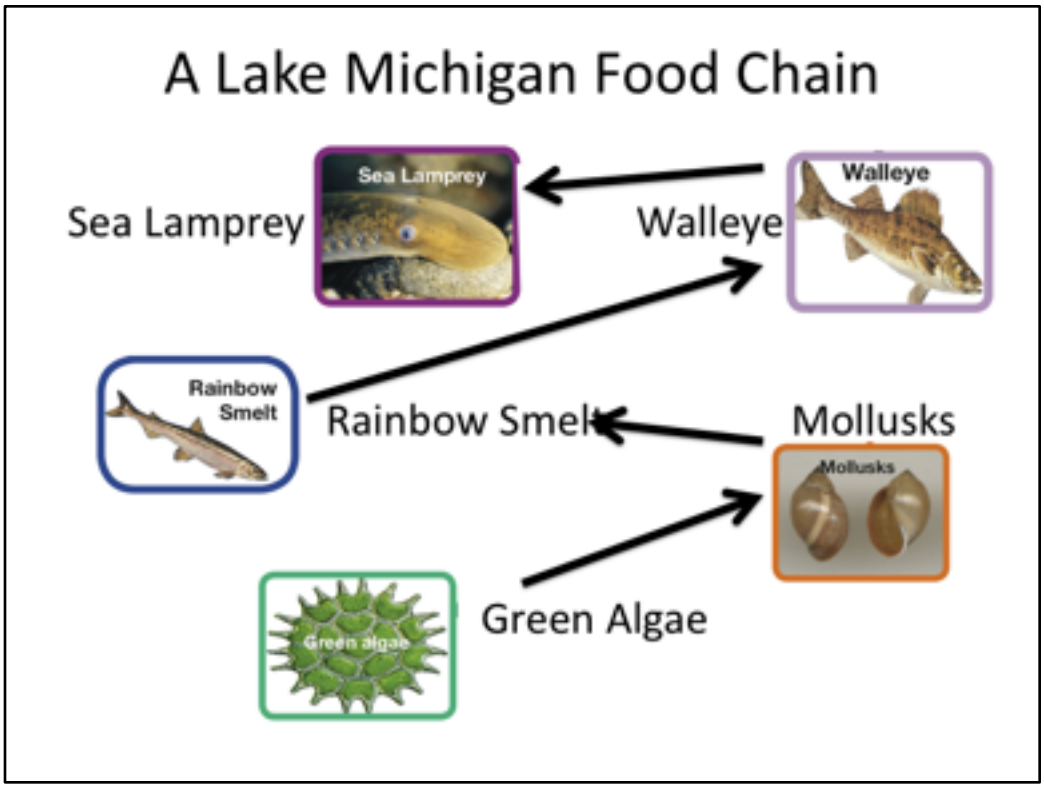


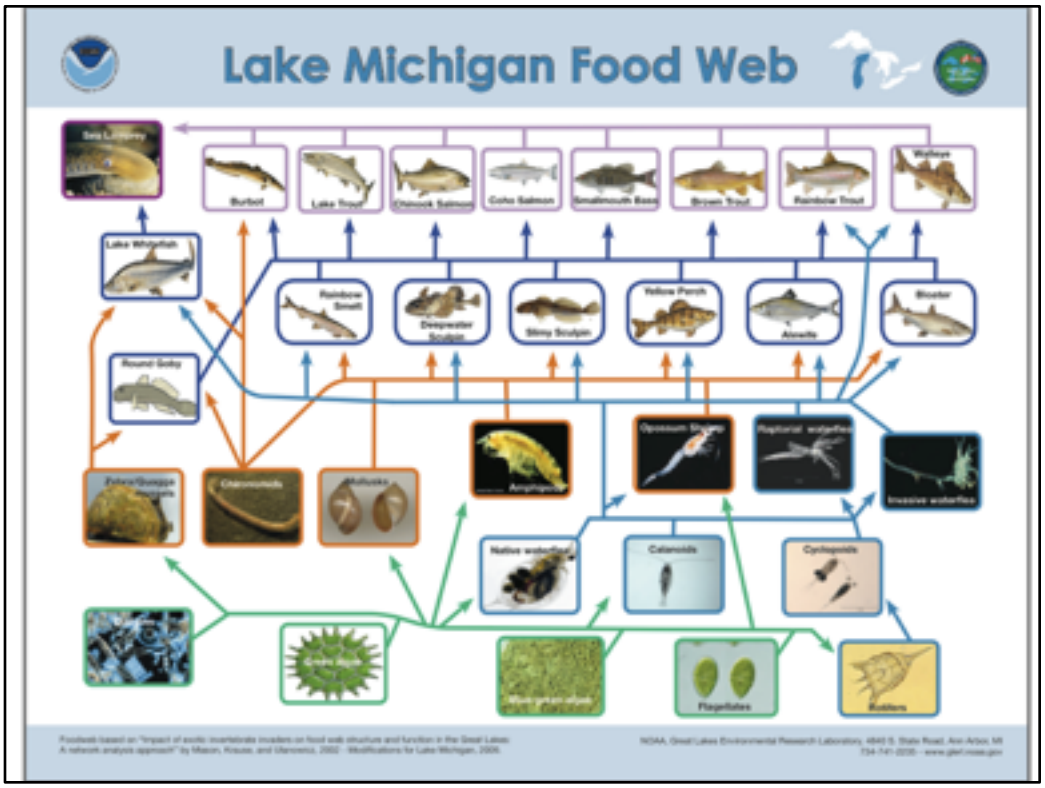
Figure 9.22 **Energy pyramid.** This idealized energy pyramid illustrates that only a portion of the energy available at one trophic level is available at the next-higher trophic level.



Source: Based on data gathered by H. T. Odum from a river ecosystem in Silver Springs, Florida.

Figure 9.24 **Energy flow diagram for Silver Springs, Florida.** How does the amount of energy (in kilocalories, or kcal) differ from one trophic level to the next? Can you calculate what percentage of energy is transferred from producers to herbivores?


A Lake Michigan Food Chain
Sea Lamprey
Sea Lamprey
Walleye
Walleye
Rainbow Smelt
Rainbow Smelt
Mollusks
Mollusks
Green Algae
Green algae



What relationship between the numbers of the primary producers and the consumers do you think you would see?

What about biomass? Energy?