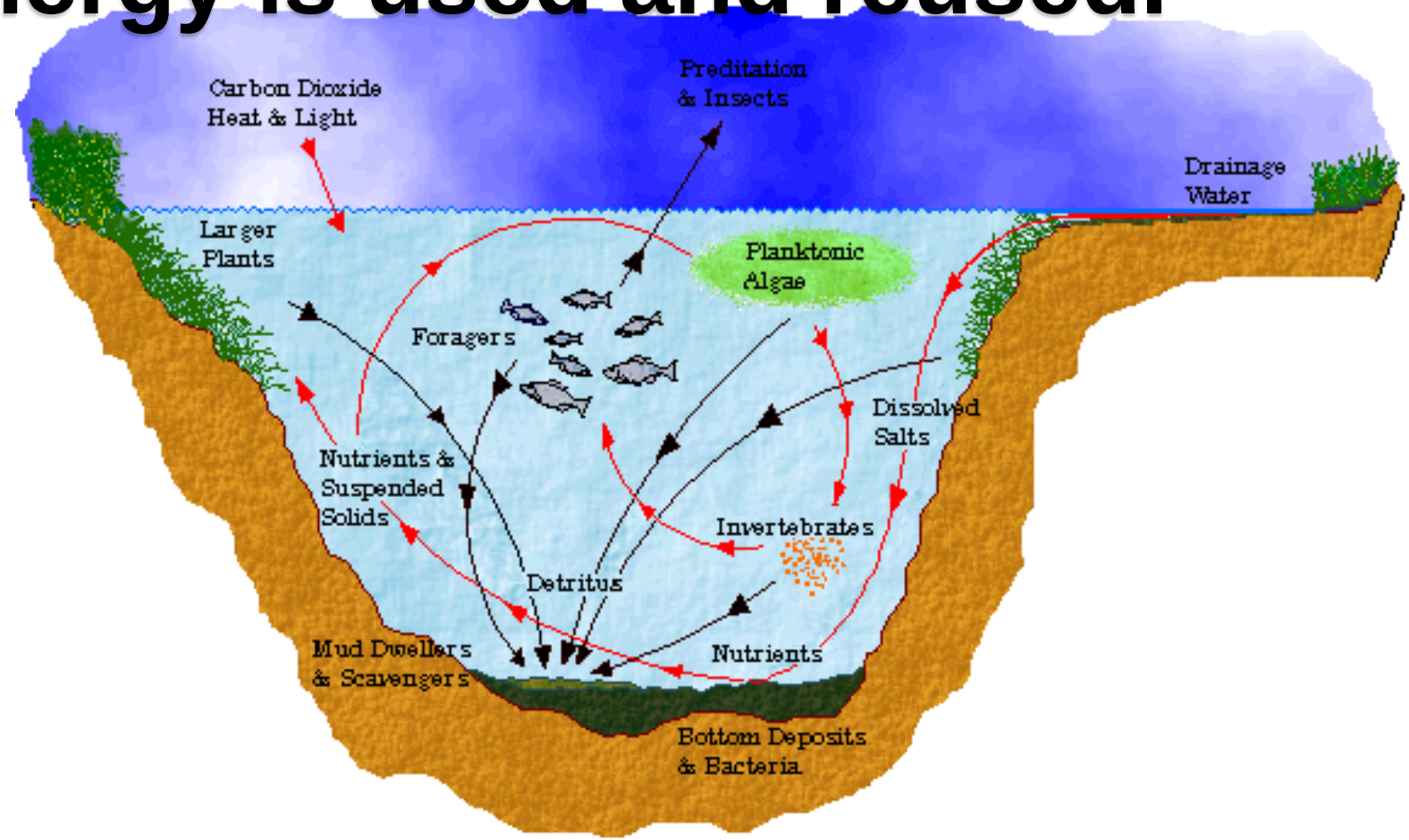
Dynamic Ecosystems

Energy Flow through an Ecosystem

Energy Transfer and Loss in Ecosystems

Ecosystem takes into account all these interactions and the energy is used and reused.



CALCULATING ENERGY LOST AT EACH TRANSFER

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What is the estimated percentage of radiant energy, captured by producers, that is used for producers own maintenance?

How much energy actually gets transferred from one trophic level to the next?

Where does the lost energy go?

Key Energy Processes

- Photosynthesis:
  - use of chlorophyll. **Energy storing process.**
  - $6\ CO_2 + 6\ H_2O +$ ***solar energy*** $\rightarrow C_6H_{12}O_6 + 6\ O_2$
- Cellular Respiration:
  - Aerobic Respiration: **energy releasing process.**
  - $C_6H_{12}O_6 + 6\ O_2 \rightarrow 6CO_2 + 6\ H_2O +$ ***energy*** (ATP)
- Anaerobic Respiration
  - Ex. Fermentation: **energy releasing process** used by yeast and bacteria

ENERGY IS LOST AT EACH TRANSFER

- The chemical energy in sugars from sunlight energy trapped by producers is used mainly by the producers themselves for staying alive.

- A small amount of this energy is available to consumers in the ecosystem.

- Energy used by producers through the process of cellular respiration and is lost as heat.

Diagrams to show Energy Flow

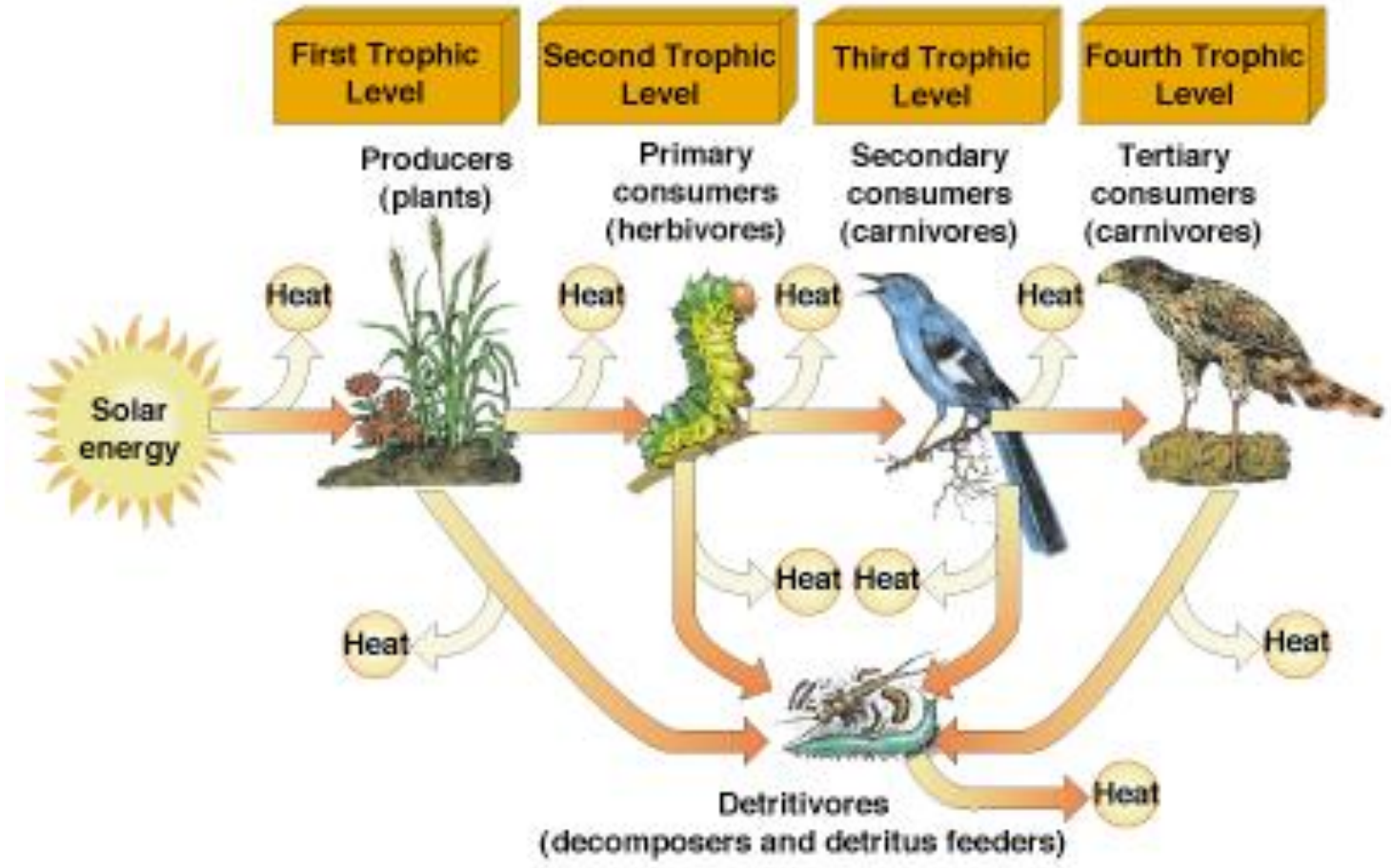
Food Chains and Food Webs

SHOWING ENERGY TRANSFERS

- Food webs and food chains show the energy transfers or energy flow in an ecosystem by indicating specifically who eats whom.
- Arrows show the direction of transfer but not the chemical energy at each transfer.
- Food Chains are a series of steps in which organisms transfer energy by eating or being eaten.
- Food webs show the complex interactions within an ecosystem.
- Each step in a food chain or web is called a trophic level. Producers make up the first step, consumers make up the higher levels.

Food Chains

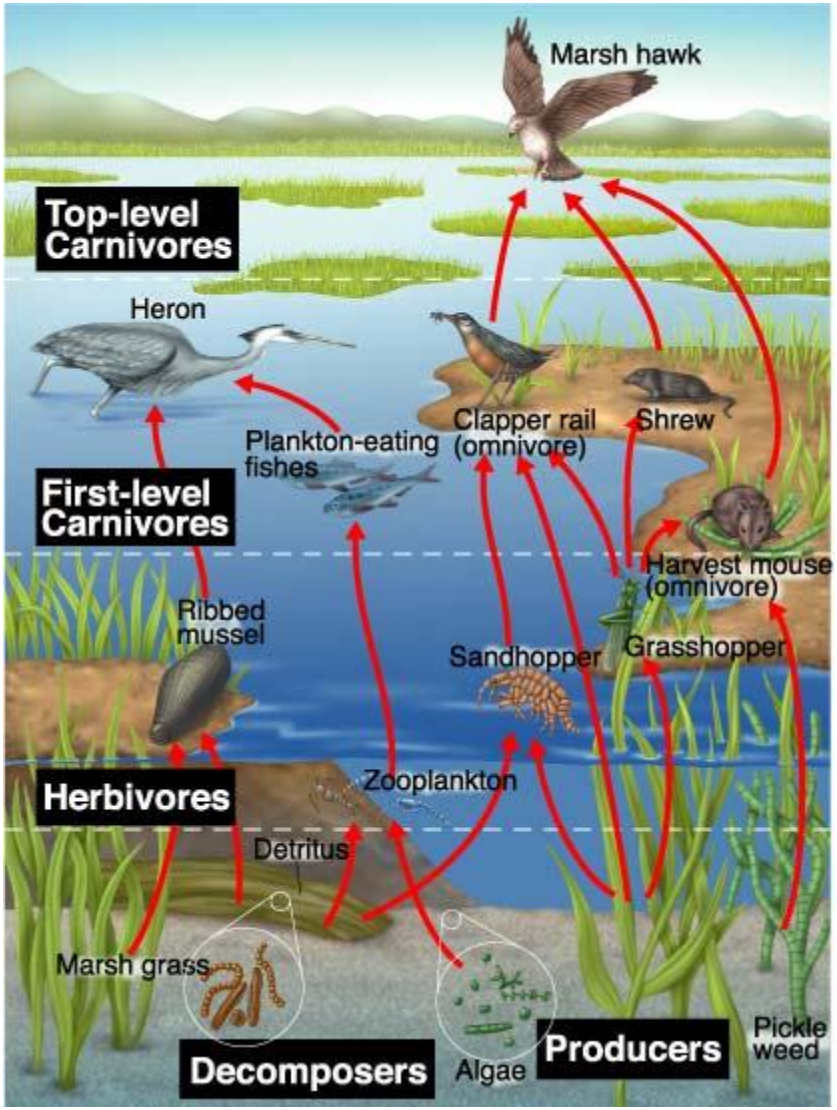
Food chains are a simple food path involving a sequence of organisms, each of which is the food for the next.

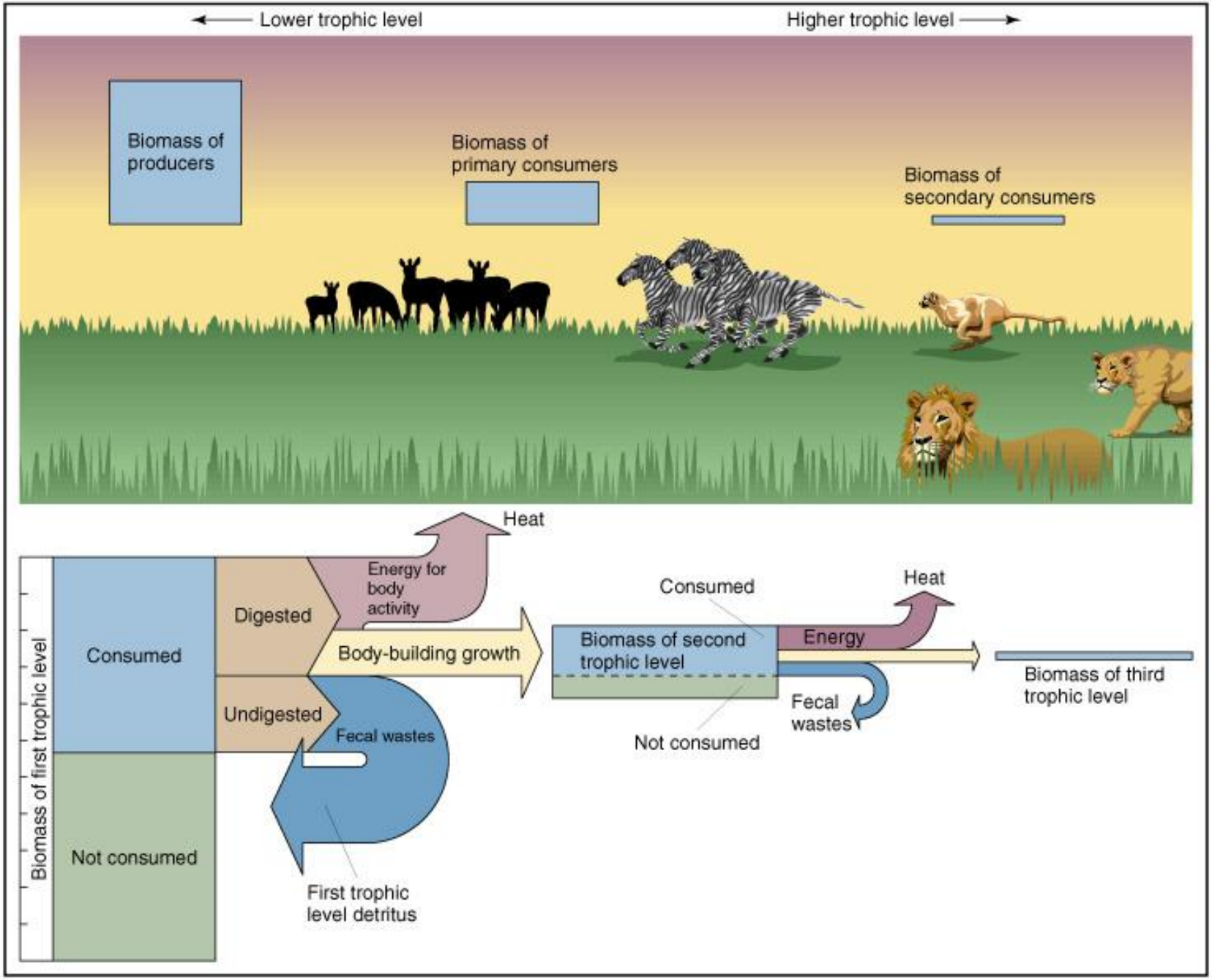


Food Webs

Food webs are multiple food chains that are interconnected. More complex than food chains.

Biomass is the dry weight of all organic matter contained in the organism within an ecosystem




Lower trophic level
Higher trophic level
Biomass of producers
Biomass of primary consumers
Biomass of secondary consumers
Heat
Energy for body activity
Digested
Consumed
Body-building growth
Undigested
Fecal wastes
Biomass of first trophic level
Not consumed
First trophic level detritus
Consumed
Heat
Biomass of second trophic level
Energy
Biomass of third trophic level
Fecal wastes
Not consumed

- Food chains and food webs do not give any information about the numbers of organisms involved.

- This information can be shown through ecological pyramids.

Diagrams to show Energy Flow

ECOLOGICAL PYRAMIDS

Ecological Pyramids

- An ecological pyramid is a diagram that shows the relationship and amounts of energy or matter contained within each trophic level in a food web or food chain.

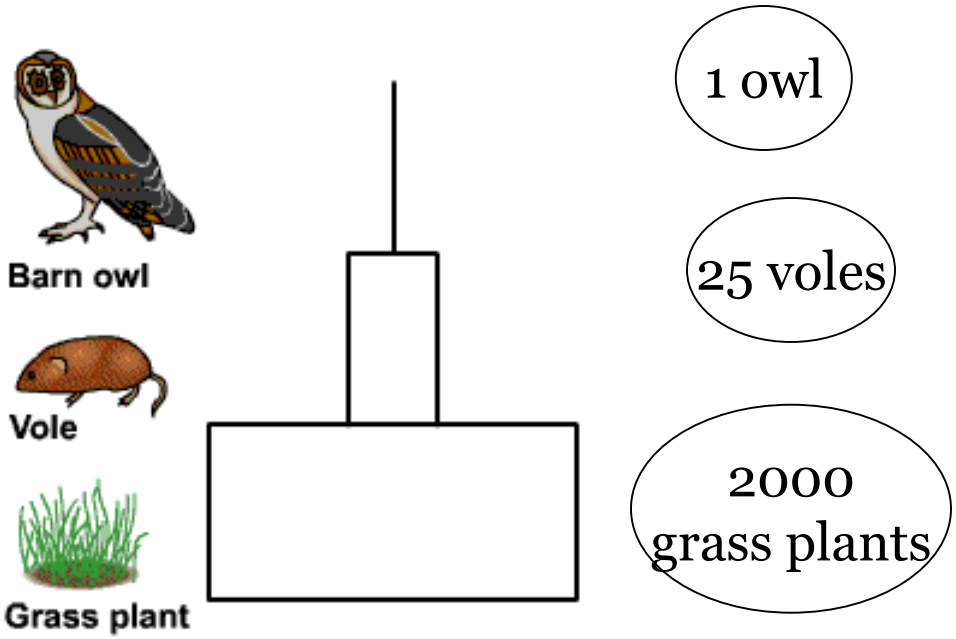
- only 10% of the energy available within one trophic level is transferred to organisms at the next trophic level.

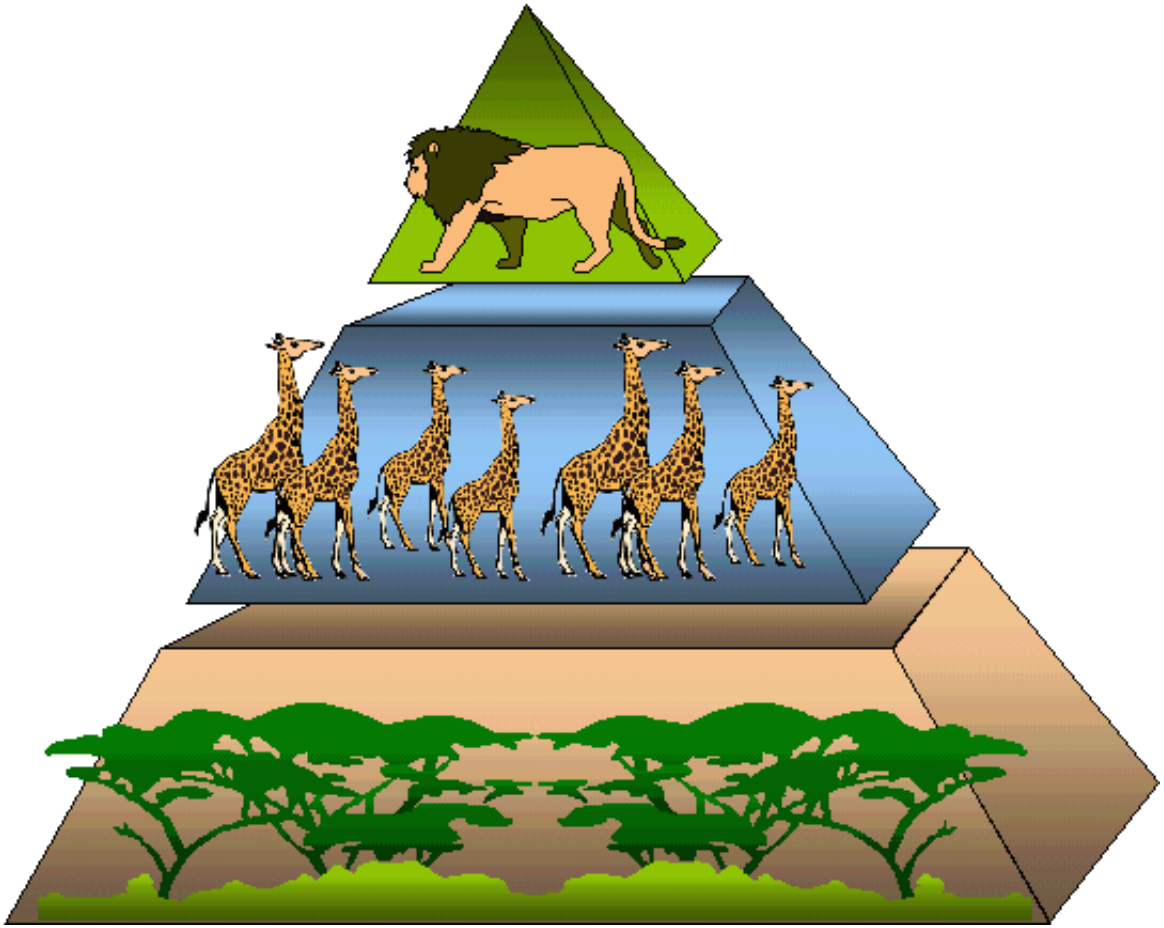
There are several types of ecological pyramids:

- Pyramid of Numbers
- Biomass Pyramid
- Energy pyramid

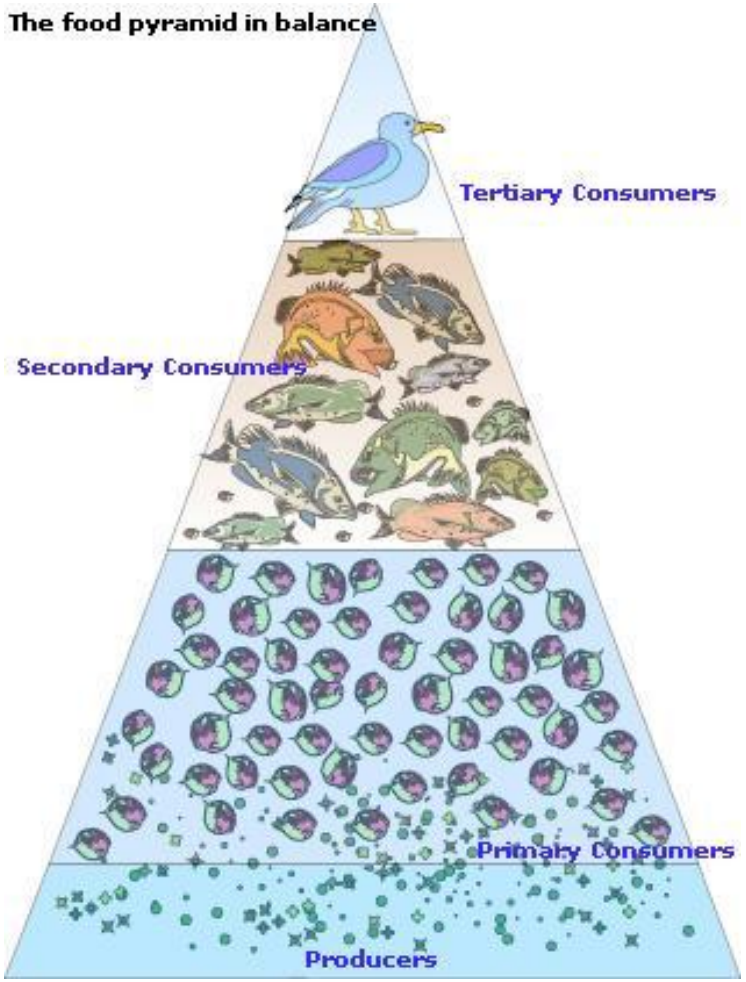
PYRAMID OF NUMBERS

Numbers pyramid shows the number of species at each trophic level

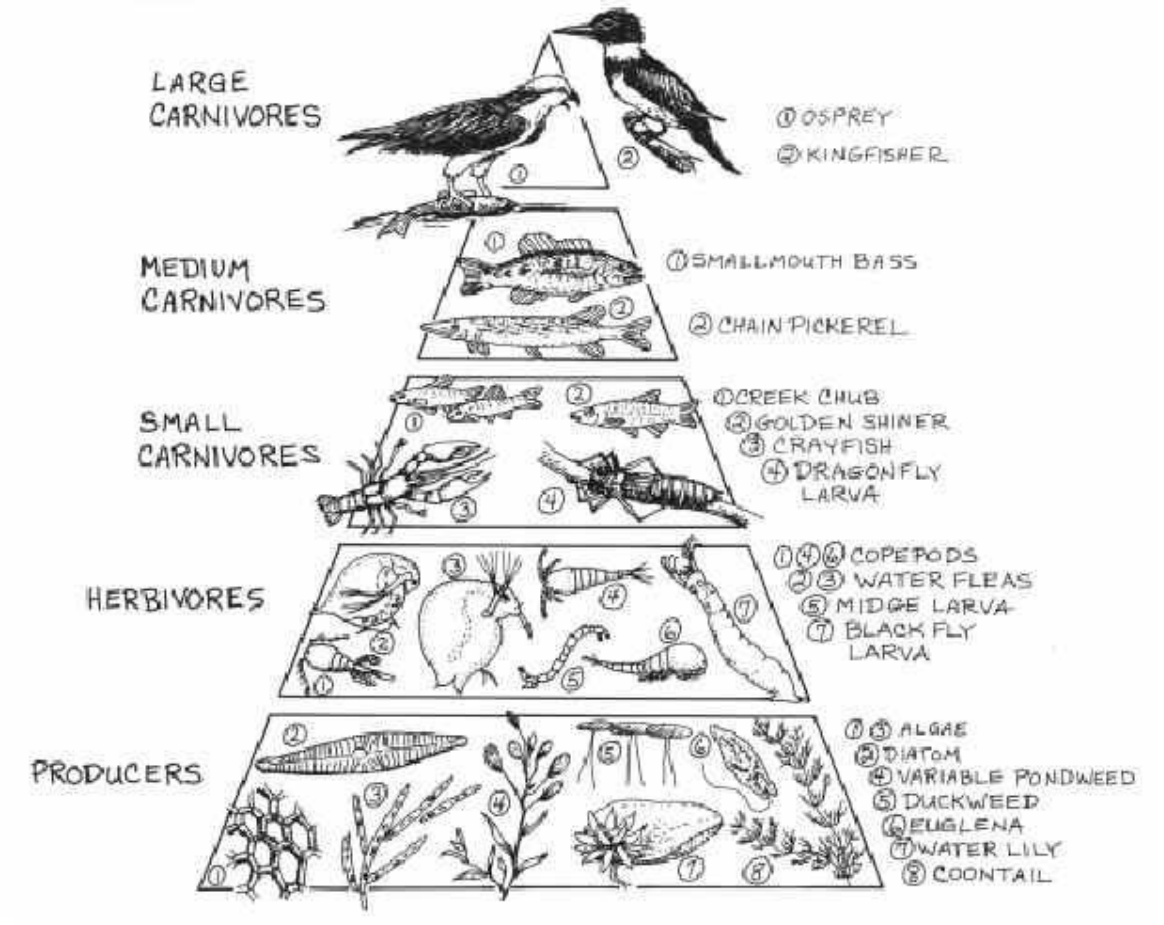




Food

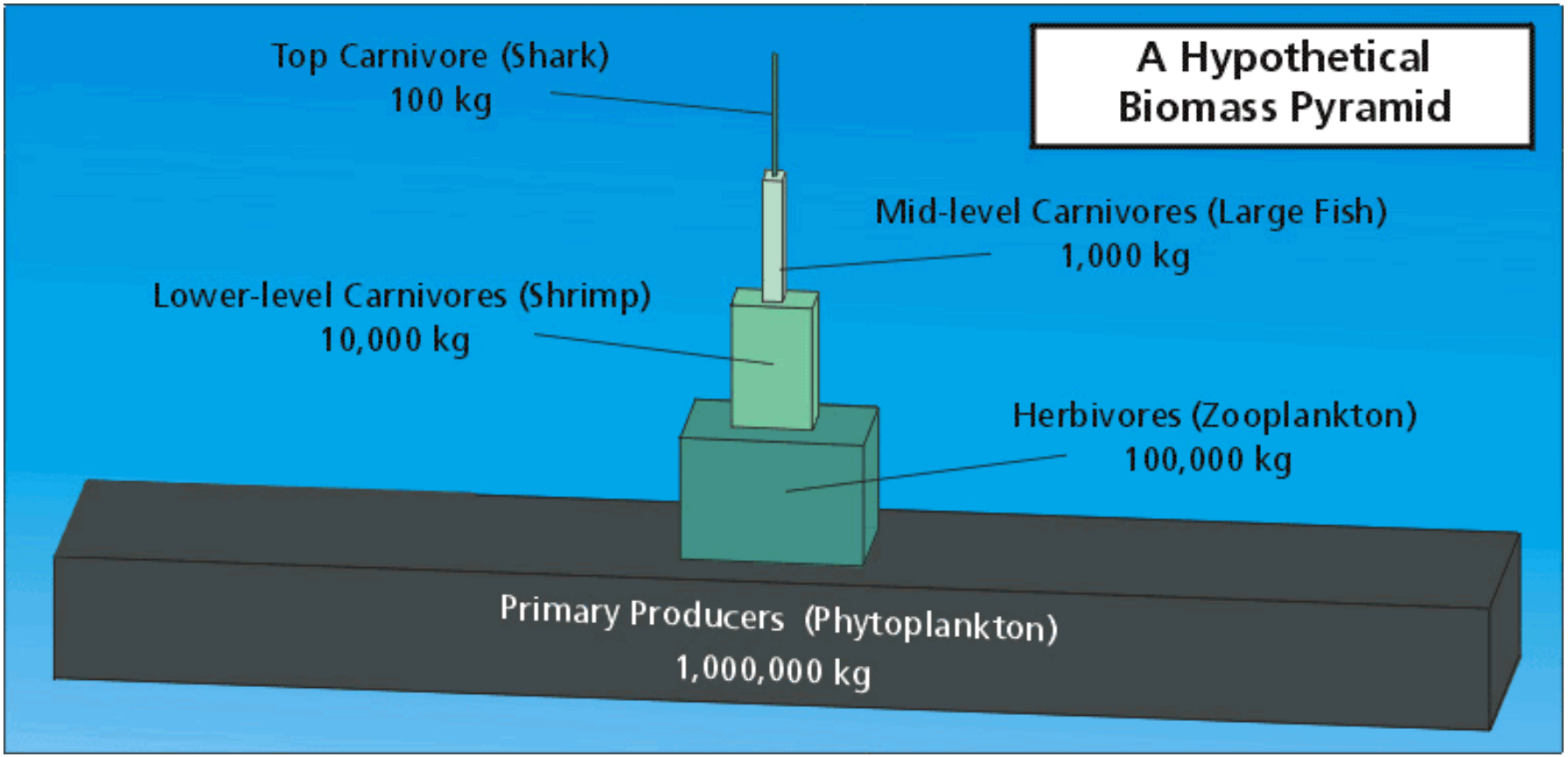

The food pyramid in balance
Tertiary Consumers
Secondary Consumers
Primary Consumers
Producers

Food pyramids



Biomass Pyramids

Biomass pyramids show the total amount of dry living tissue or matter (biomass) available at each trophic level. This shows the amount of tissue available for the next trophic level.



PYRAMID OF BIOMASS

- Biomass is preferred to the use of numbers of organisms because individual organisms can vary in size. It is the total mass not the size that is important.

- Pyramid of biomass records the total dry organic matter of organisms at each trophic level in a given area of an ecosystem.

PYRAMID OF ENERGY

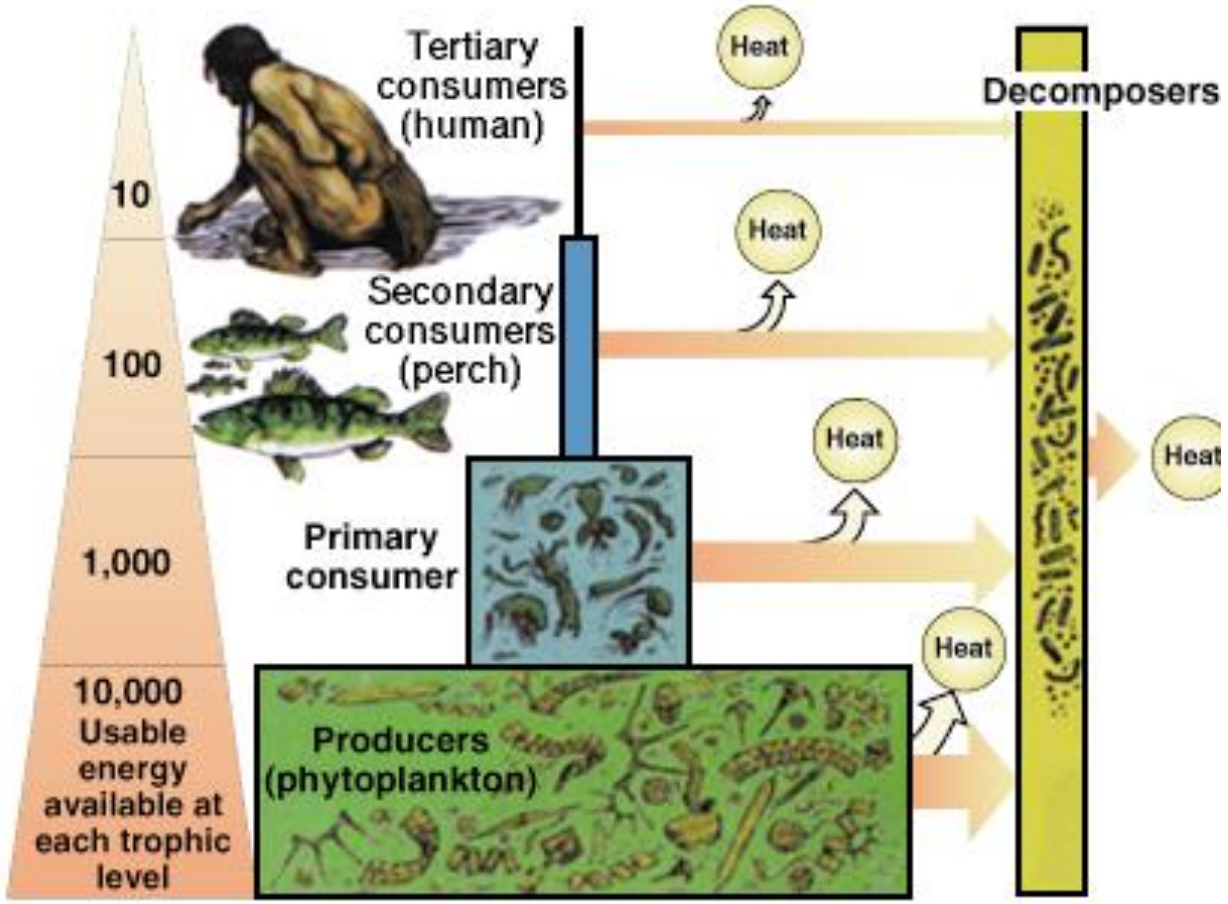
Shows the amount of energy input to each trophic level in a given area of an ecosystem over an extended period.

Why will this type of pyramid never be inverted?

Energy Pyramid

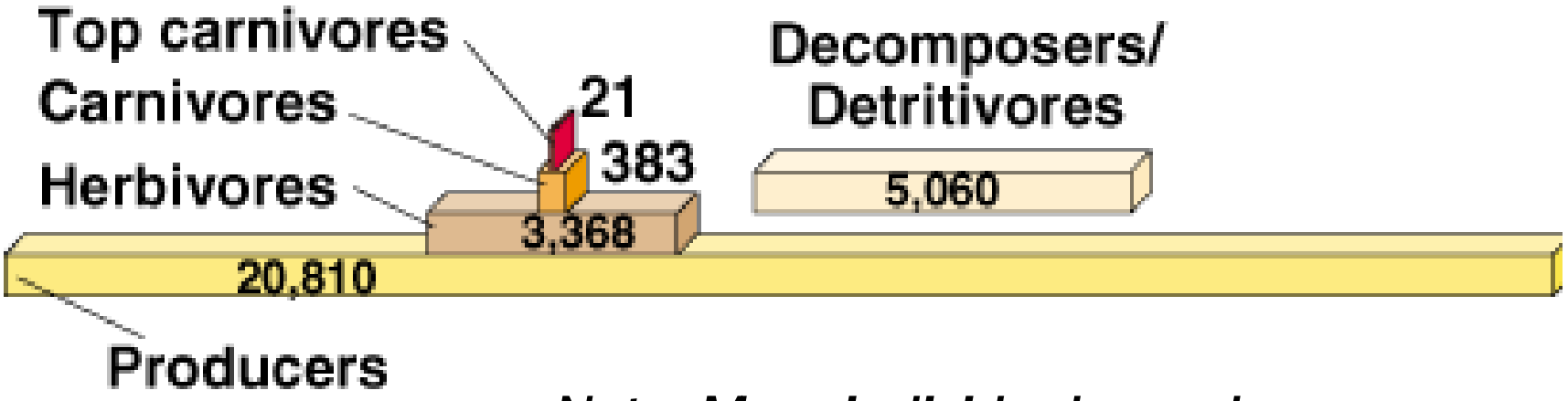
In nature, ecological efficiency varies from 5% to 20% energy available between successive trophic levels (95% to 80% loss).

About 10% efficiency is a general rule.



Another Energy Pyramid

Annual pyramid of energy flow (in kilocalories per square meter per year) for an aquatic ecosystem in Silver Springs, FL.



Note: More individuals can be supported at lower trophic levels. Less energy is lost.

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Page 326 Ecological pyramids

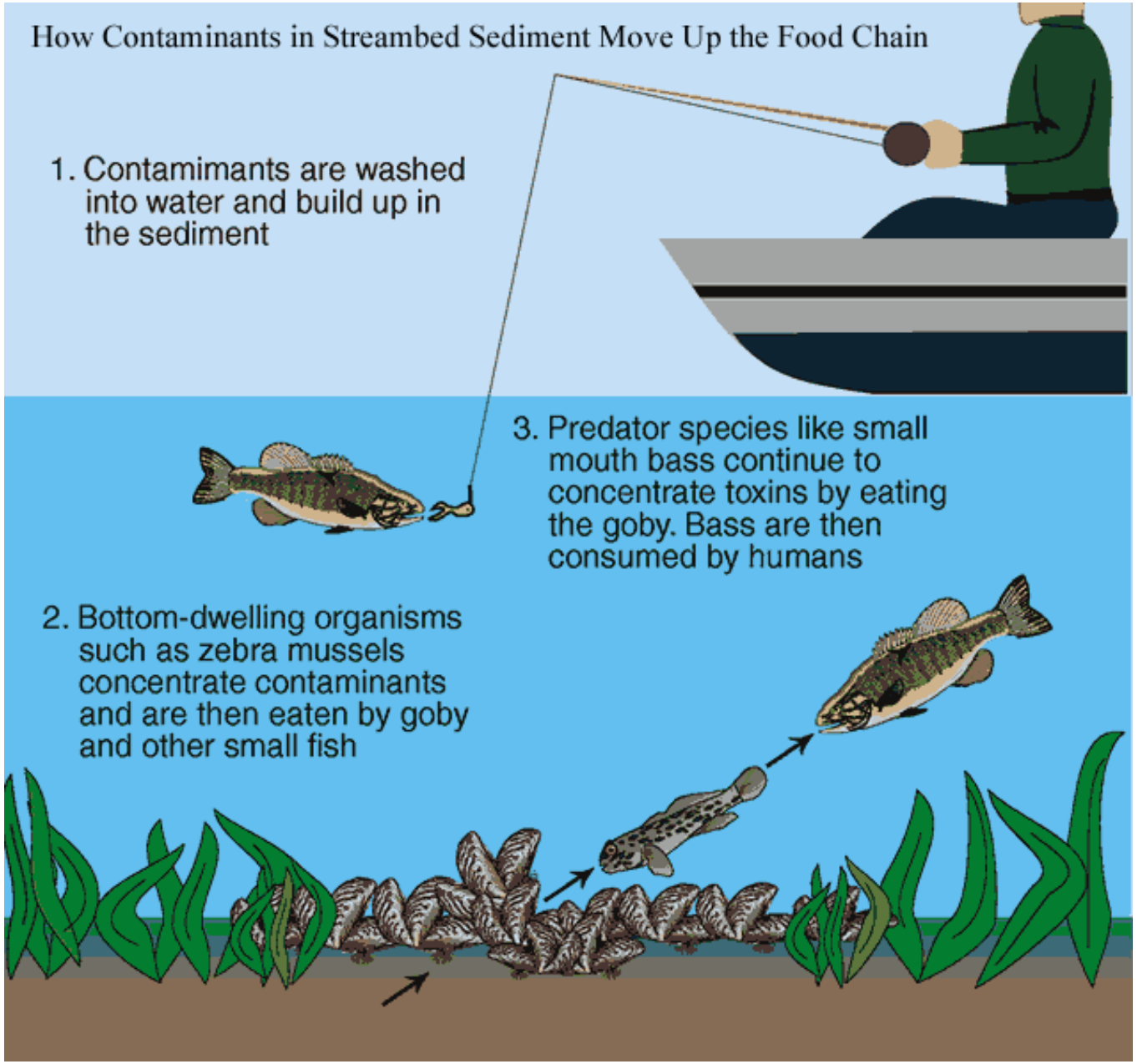
Biomagnification
or
Bioaccumulation

BIOMAGNIFICATION

This is when substances such as pesticides , radioactive isotopes, heavy metals, and industrial chemicals such as PCBs can be taken in by organisms via their food or sim[ply absorbed by the surrounding medium.

These substances are usually resistant to being broken down and not readily excreted.

Higher order consumers are more at risk as they eat a larger number of low order consumers. As a result the amount of metals are more concentrated.


How Contaminants in Streambed Sediment Move Up the Food Chain
1. Contamimants are washed into water and build up in the sediment
3. Predator species like small mouth bass continue to concentrate toxins by eating the goby. Bass are then consumed by humans
2. Bottom-dwelling organisms such as zebra mussels concentrate contaminants and are then eaten by goby and other small fish

Susan Shaw: The oil spill's toxic trade-off Break down the oil slick, keep it off the shores: that's grounds for pumping toxic dispersant into the Gulf, say clean-up overseers. Susan Shaw shows evidence it's sparing some beaches only at devastating cost to the health of the deep sea.

http://blog.ted.com/2010/07/27/the_oil_spills_1/

Example 1
Methylmercury

When mercury enters the water, it is changed into a more toxic substance called methylmercury.

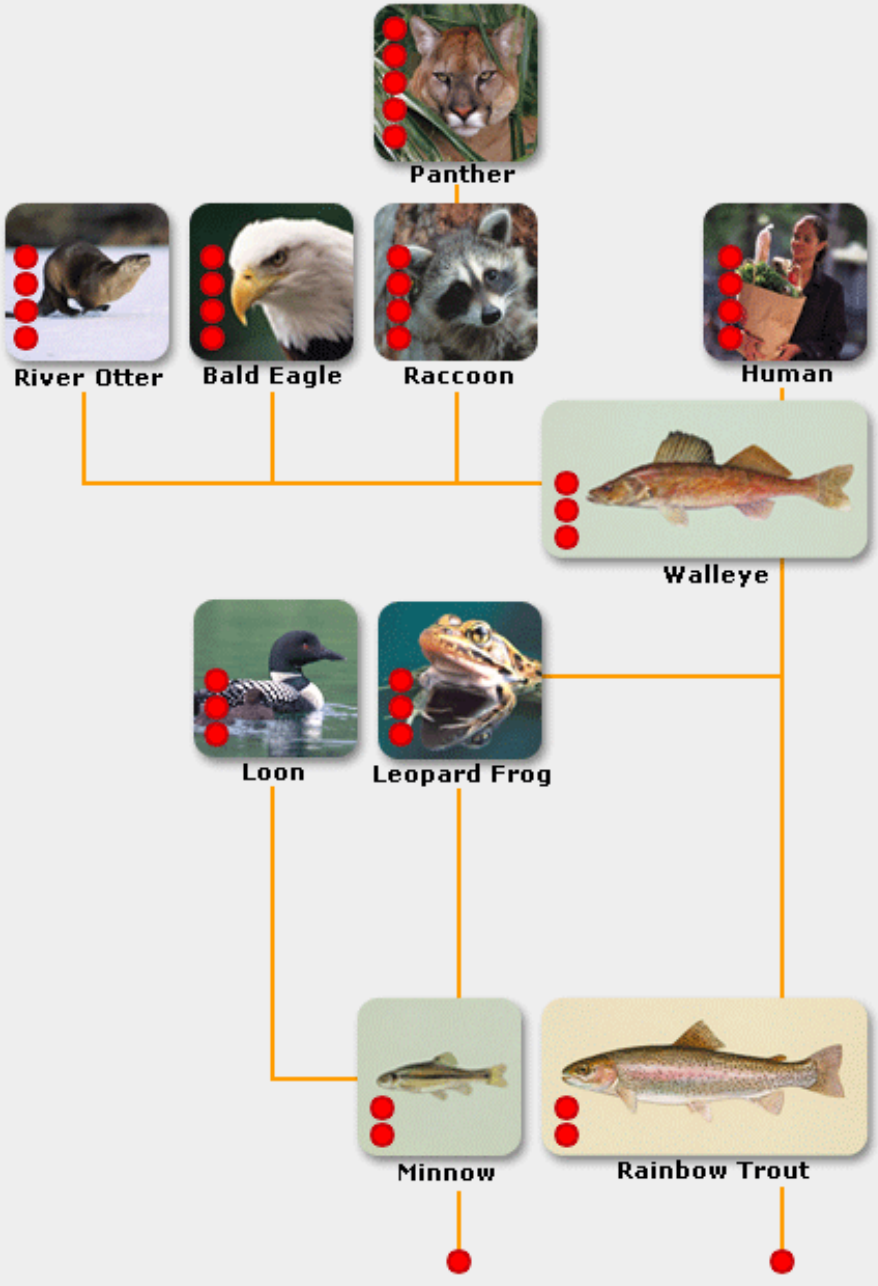
Methylmercury is absorbed by bacteria and small plants. These bacteria and plants are eaten by small fish, which in turn are eaten by larger fish.

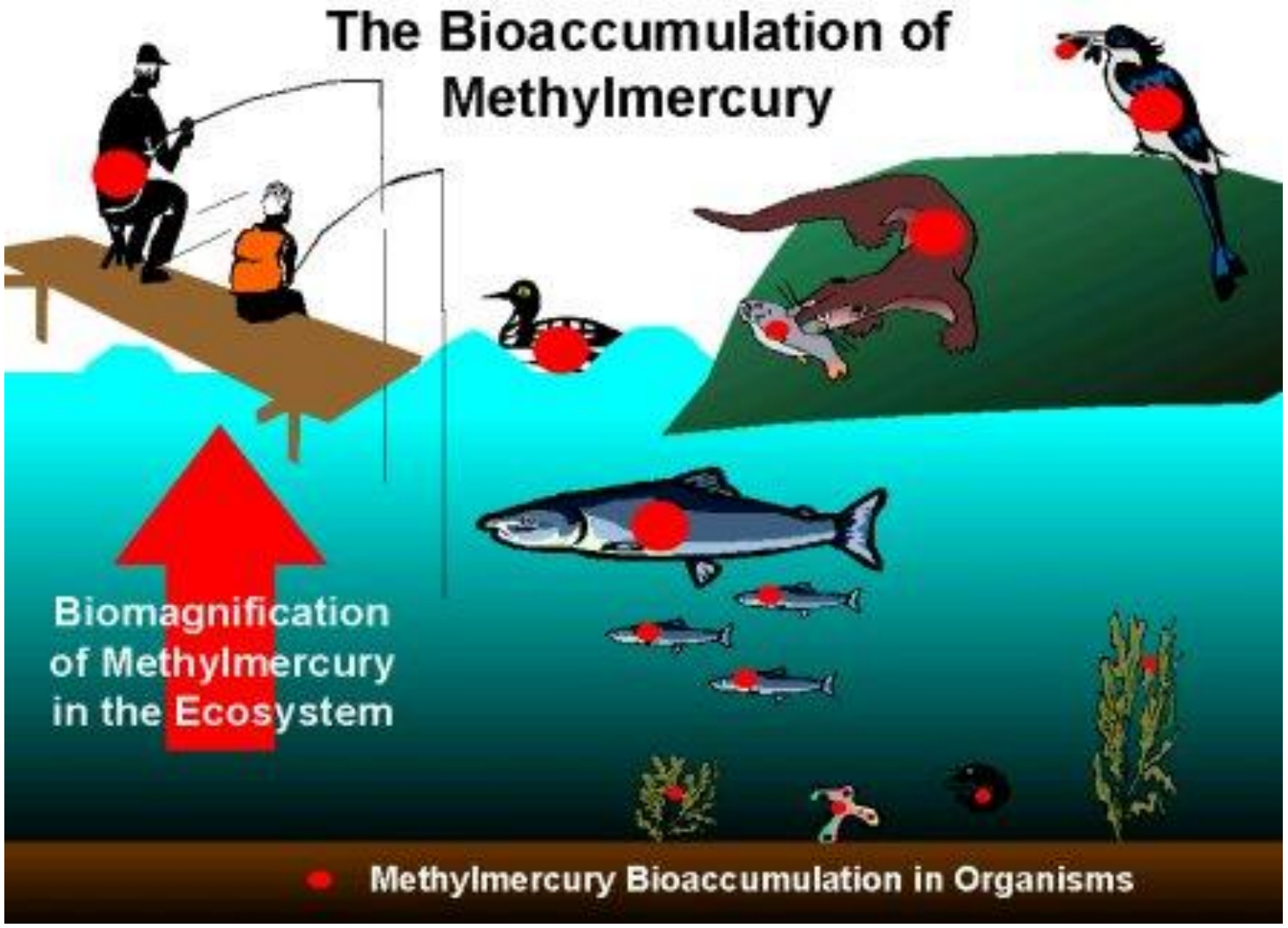
By the time a fish-eating bird or mammal eats the larger fish, the concentration of methylmercury in the fish can be up to a million times higher than in the surrounding water.

Mercury gets into the environment as a result of human uses of mercury in products and in industry and the combustion of fossil fuels that contain mercury.

Forest fires, the evaporation of seawater and volcanoes also contribute mercury into the environment.

An estimated two-thirds of mercury in the environment is the result of human activities.


Panther
River Otter
Bald Eagle
Raccoon
Human
Walleye
Loon
Leopard Frog
Minnow
Rainbow Trout
indicates the concentration of methylmercury as it moves up the food chain


The Bioaccumulation of Methylmercury
Biomagnification of Methylmercury in the Ecosystem
Methylmercury Bioaccumulation in Organisms

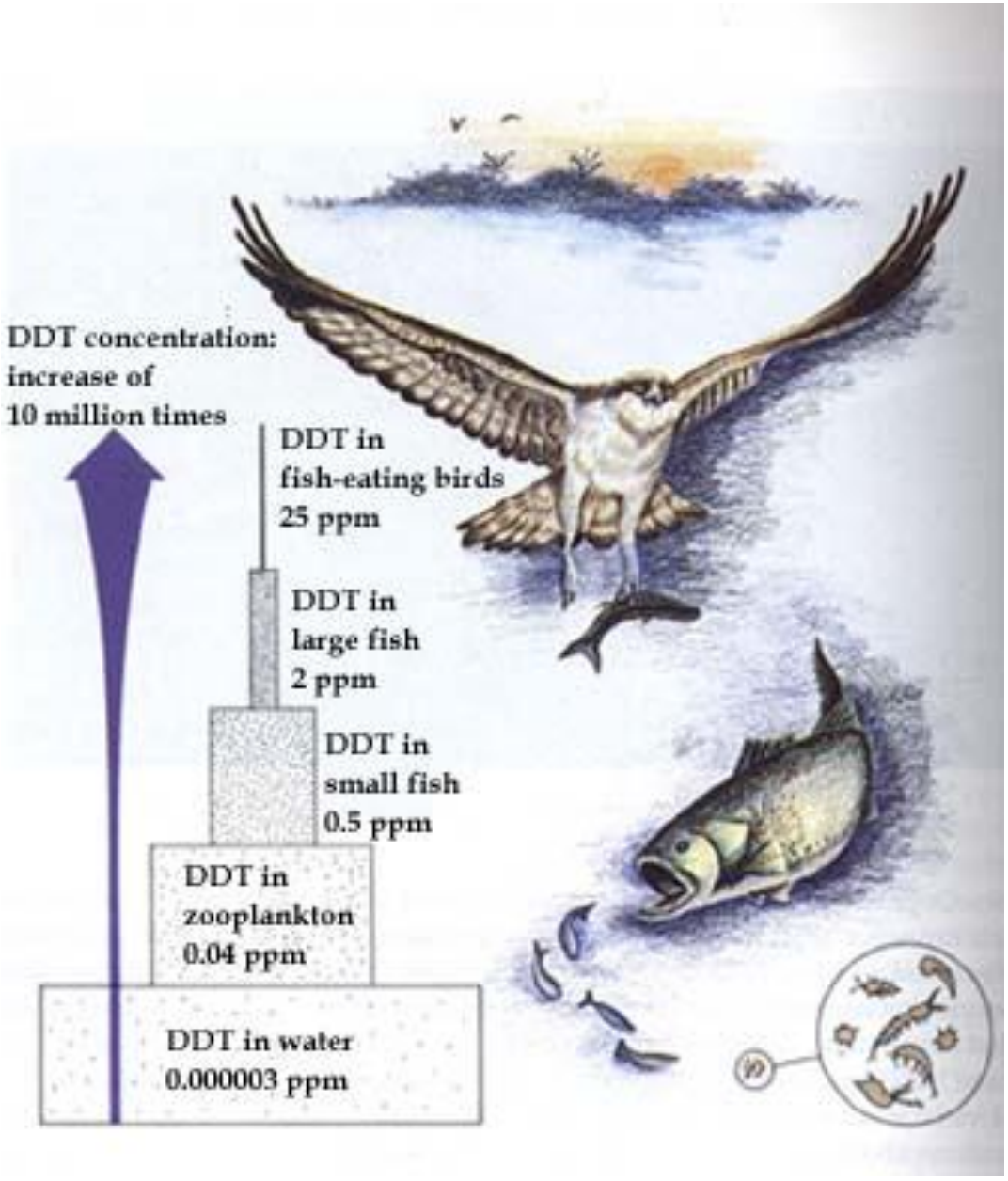
Example 2 - DDT

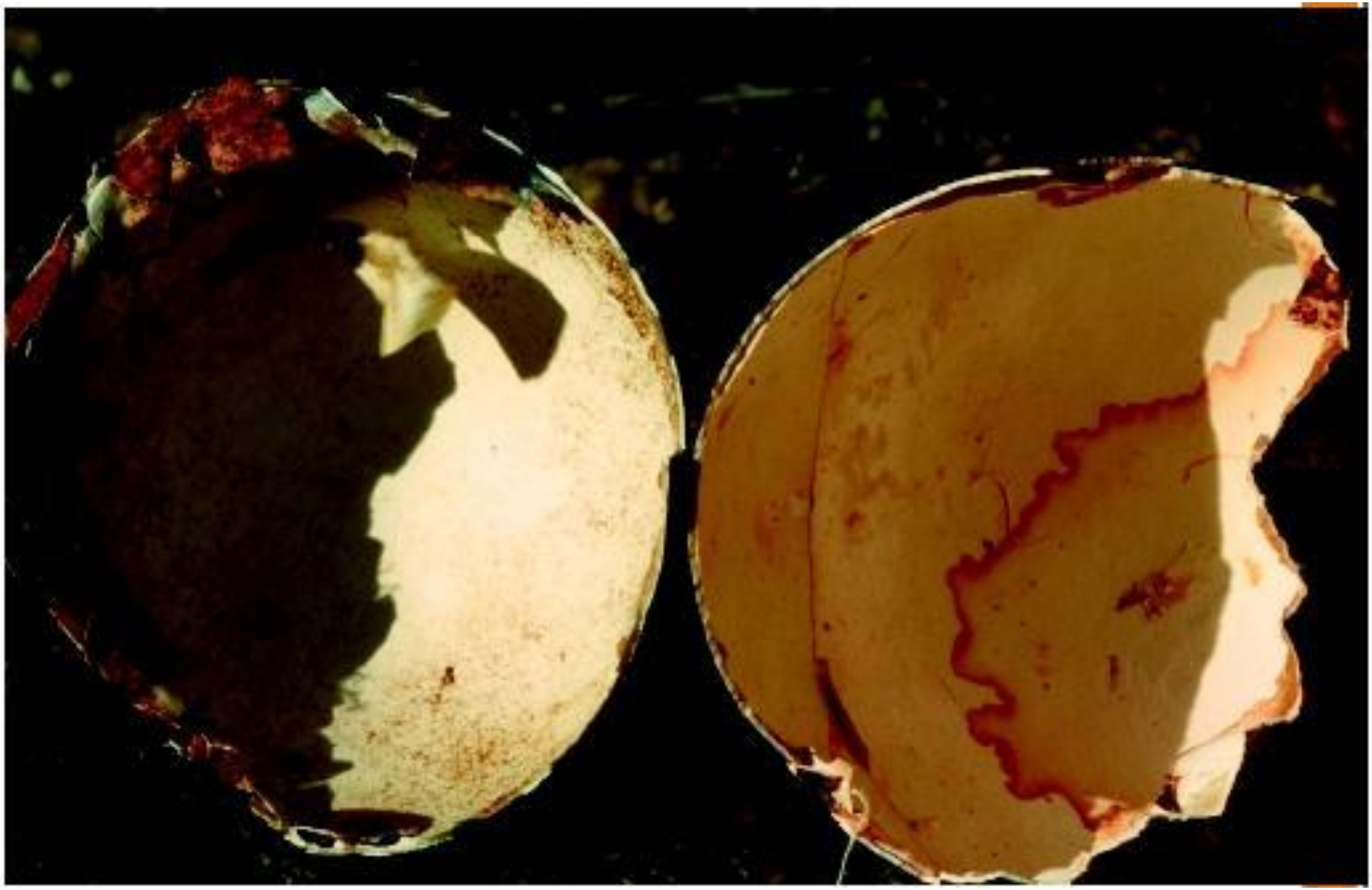
DDT is a man-made chemical that was widely used to control insects on agricultural crops and insects that carry diseases like malaria and typhus.

DDT accumulates in the fat of humans, livestock, aquatic food chains, and wildlife.

Many predatory birds were heavily impacted by DDT. The peregrine falcon was severely affected by DDT as it prevented normal calcium deposition during eggshell formation.

This caused females to lay thin-shelled eggs that often break before hatching.


DDT concentration:
increase of
10 million times
DDT in
fish-eating birds
25 ppm
DDT in
large fish
2 ppm
DDT in
small fish
0.5 ppm
DDT in
zooplankton
0.04 ppm
DDT in water
0.000003 ppm




7-16:57 74F/23C RFALCONCAM.COM

Biozone

- Page 320. Pesticides and Biomagnification.

Cycles of Matter

- Unlike the one-way flow of energy, matter is recycled within and between ecosystems.

- These cycles are the water cycle, Nutrient Cycle, Carbon Cycle, nitrogen cycle and phosphorus cycle.