Trophic interactions

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Consumer-resource interactions (general predator-prey relationship)

1. Types of predation
2. Predator-prey cycles
3. Why predators don't kill all their prey?
4. Food web

Predation (in broad ecological terms)

Any interaction between two species in which one is benefited and the other is harmed.

Density of one species changes the ***per capita*** population growth rate of the other

Species A (*resource*) --- **+** ---> Species B (*consumer*)

Species A (*resource*) <--- **-** --- Species B (*consumer*)

Types of predation

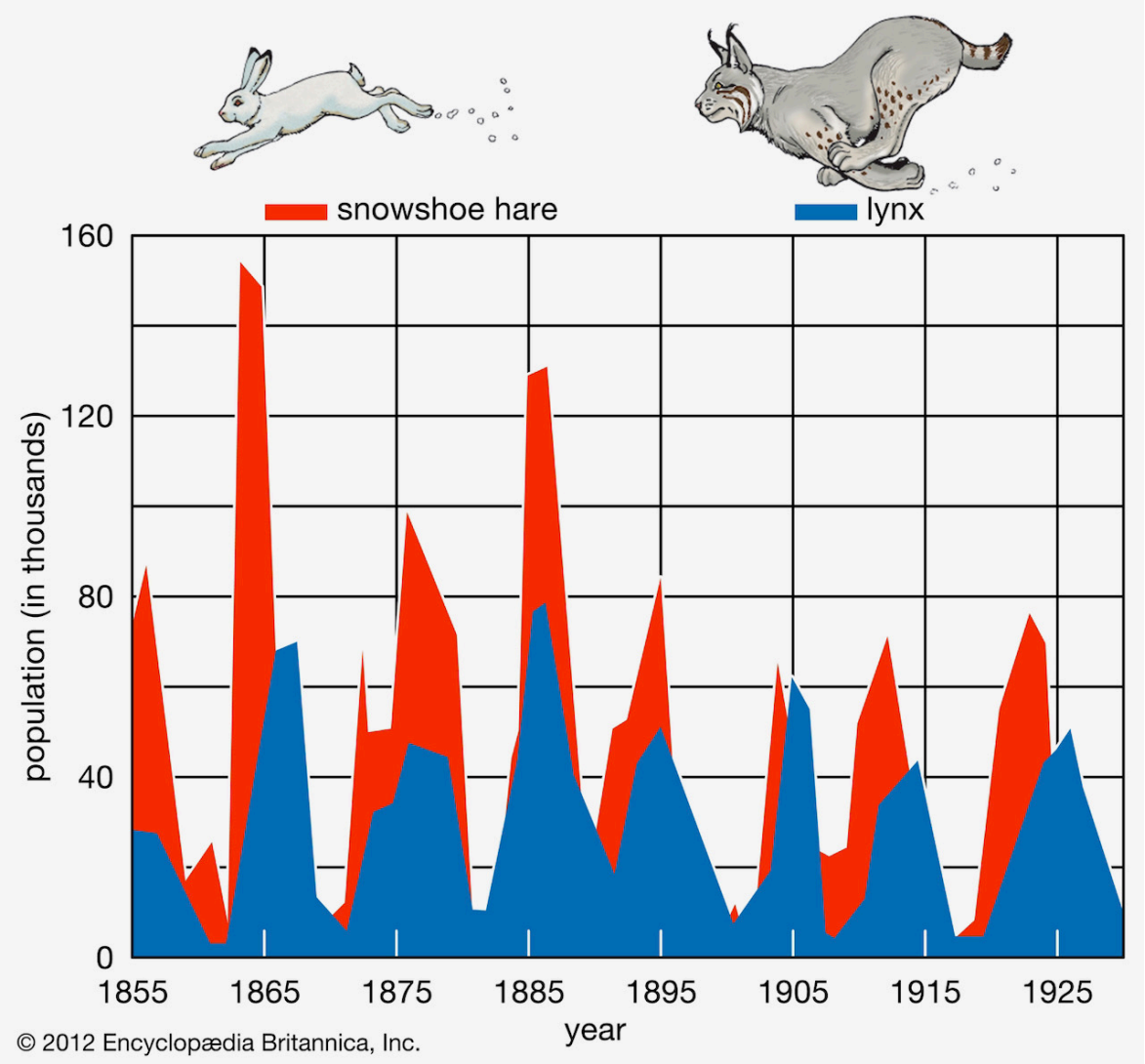
A. Predator-prey (e.g., lions and wildebeests)

B. Herbivore-plant (e.g., rabbits and dandelions)

C. Parasite-host (e.g., filariasis and humans)

Is this a predator-prey interaction?

Predator-prey cycles



Lotka-Volterra model

Predator (Consumer)

$$\frac{dC}{dt} = -qC$$

$$\frac{dC}{dt} = -qC + caCR$$

Prey (Resource)

$$\frac{dR}{dt} = rR$$

$$\frac{dR}{dt} = rR - aCR$$

The consumer and resource oscillate together through time, with the consumer lagged forward in time relative to the resource dynamics.

Equilibrium

Predator (Consumer)

$$\begin{aligned}
\frac{dC}{dt} &= caCR - qC \\
0 &= caCR - qC \\
caCR &= qC \\
caR &= q \\
R* &= \frac{q}{ca}
\end{aligned}$$

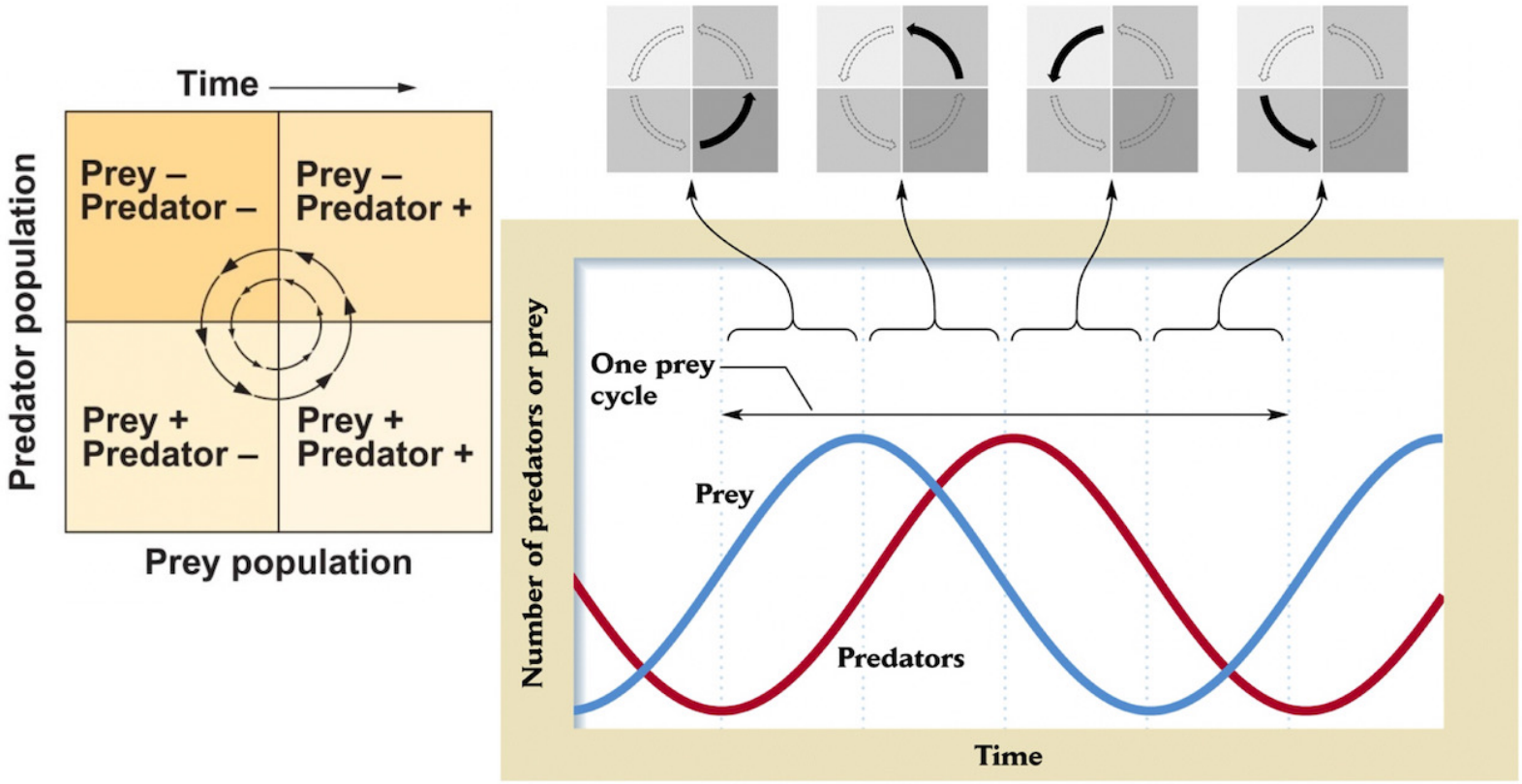
Predator population will be stable when the number of preys equals the ratio of the predator's mortality rate and its attack times conversion rate.

Prey (Resource)

$$\begin{aligned}
\frac{dR}{dt} &= rR - aCR \\
0 &= rR - aCR \\
aCR &= rR \\
aC &= r \\
C* &= \frac{r}{a}
\end{aligned}$$

Prey population will be stable when the number of predators equals the ratio of the prey's growth rate and predator's attack rate.

Predator-prey models predict stable limit cycles

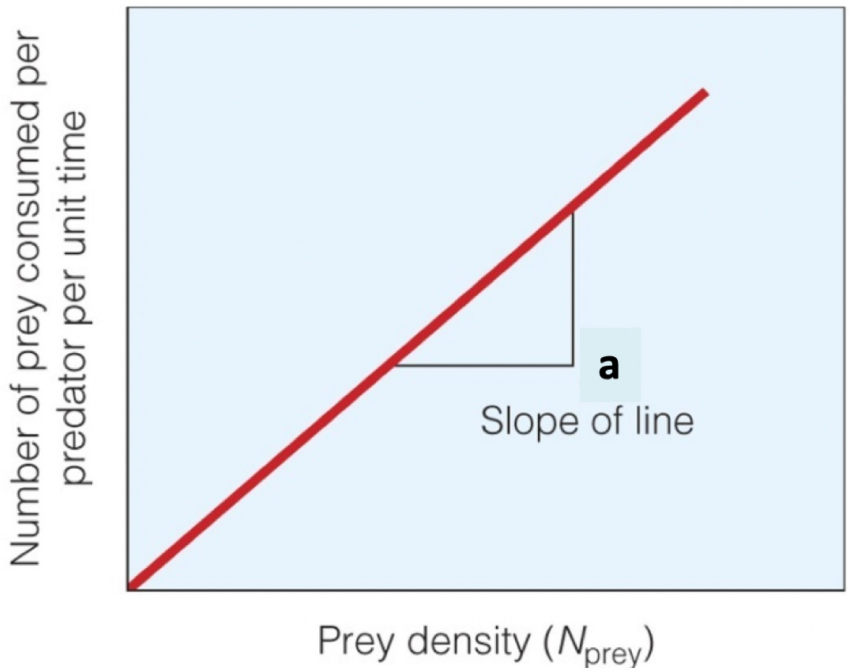


Model assumptions

- Resource population only limited by predator
- Predator (C) only eats the one resource R
- Individual predators consume infinite number of R
- Encounter of predator C and resource R is random and "well-mixed" (homogenous habitats)

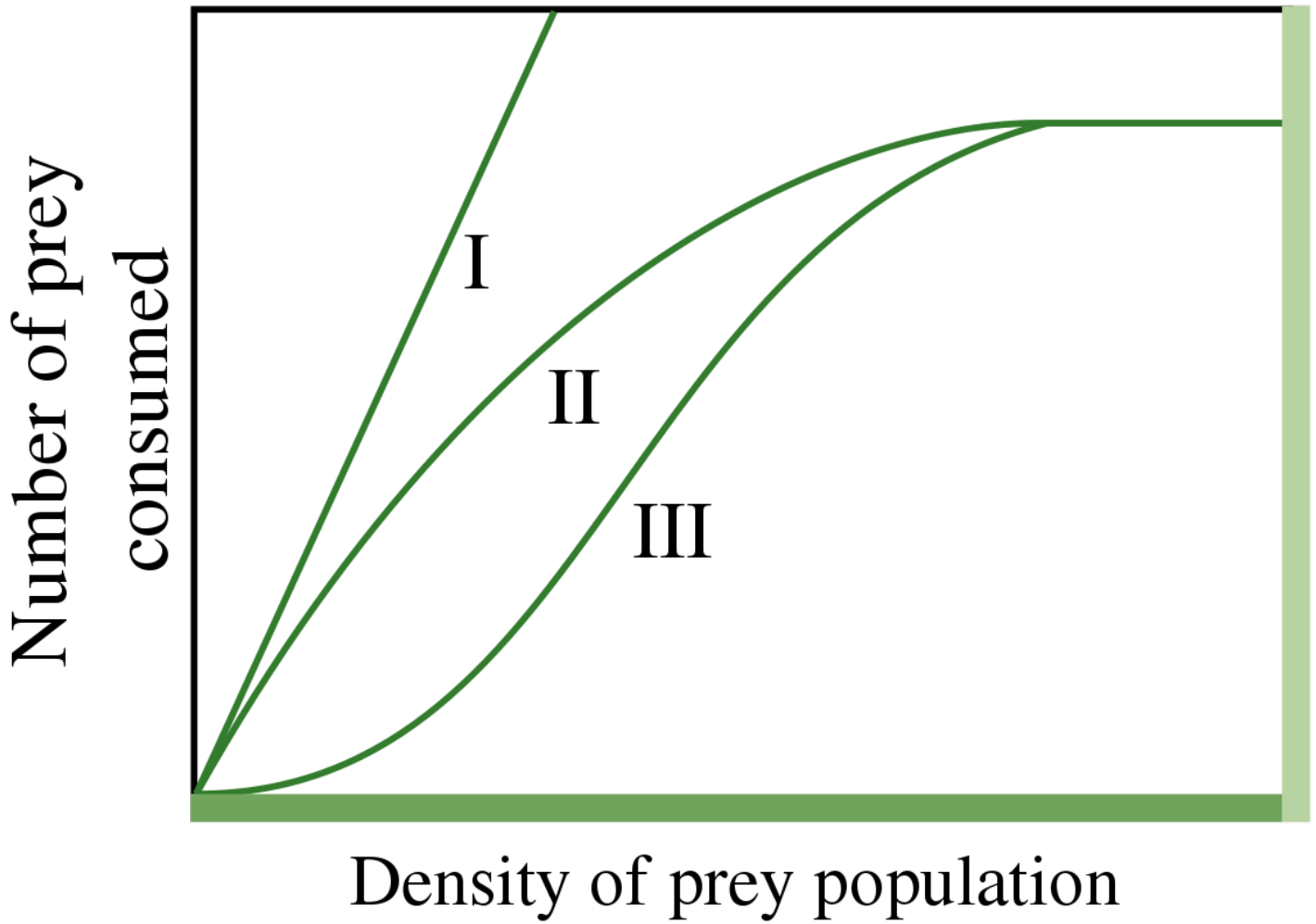
How can we make the L-V model more realistic?

Individual predators consume infinite number of *R*



Type I *functional response* (relationship between the density of prey and an individual predator's rate of resource consumption)

Functional response types

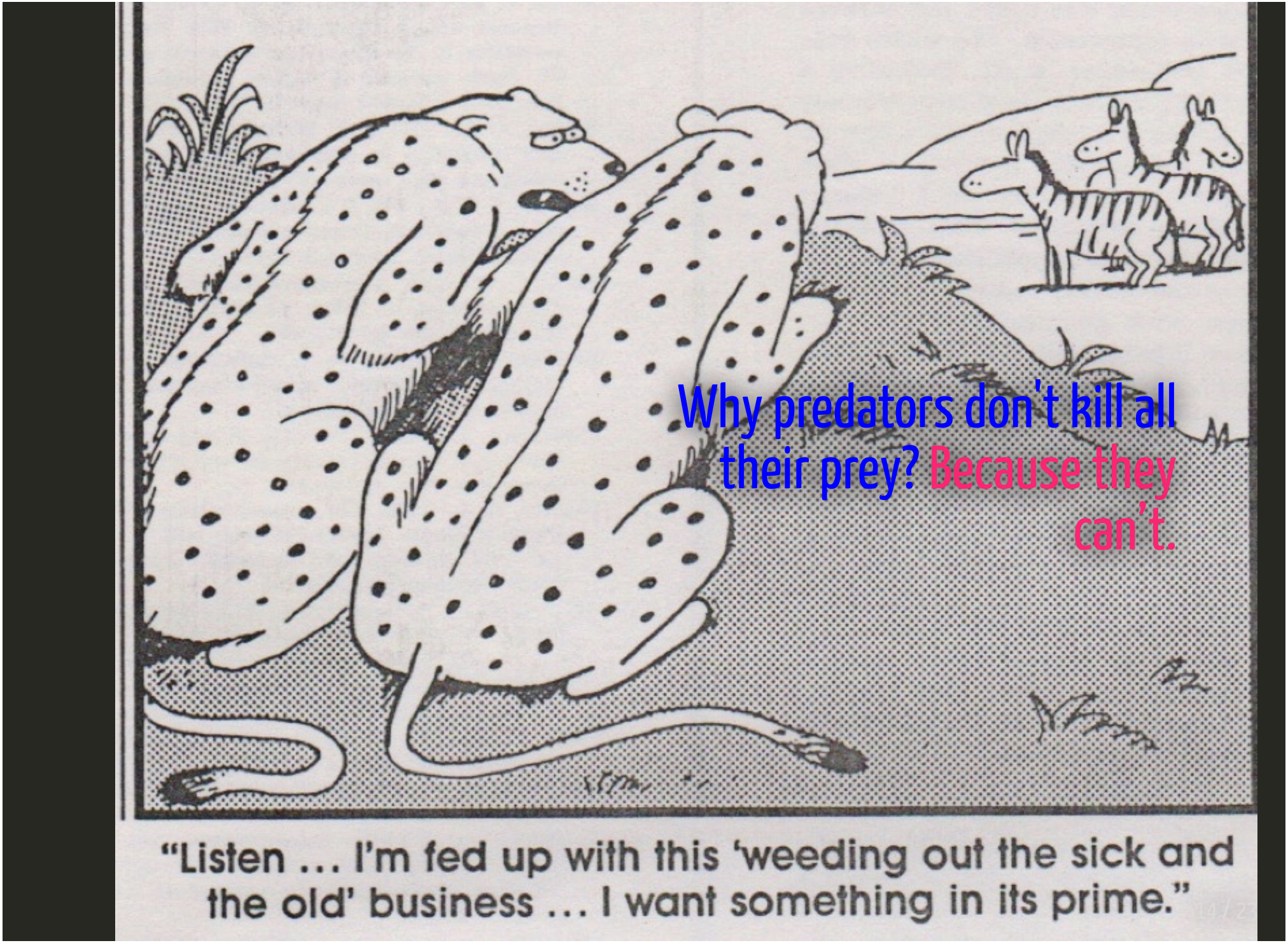


Why predators don't kill all their prey?

Because this would cause their own extinction?

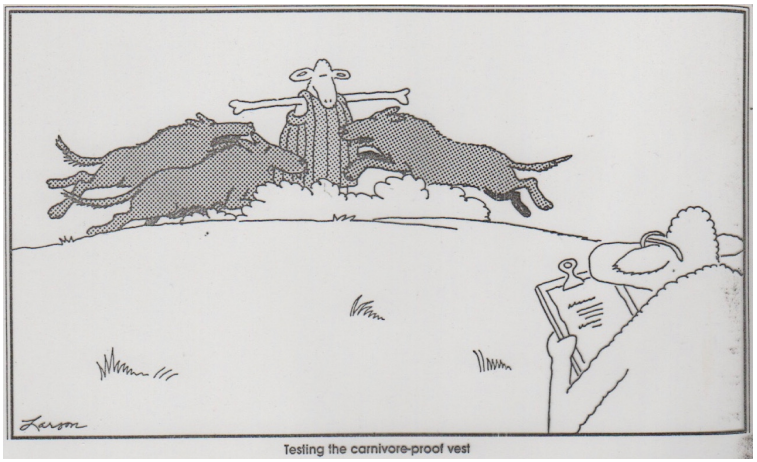
Or even further, some may say that the predators actually act in the best interest of the prey by removing the "old and sick."

Wrong! Because predators do not act this way, nor should they.

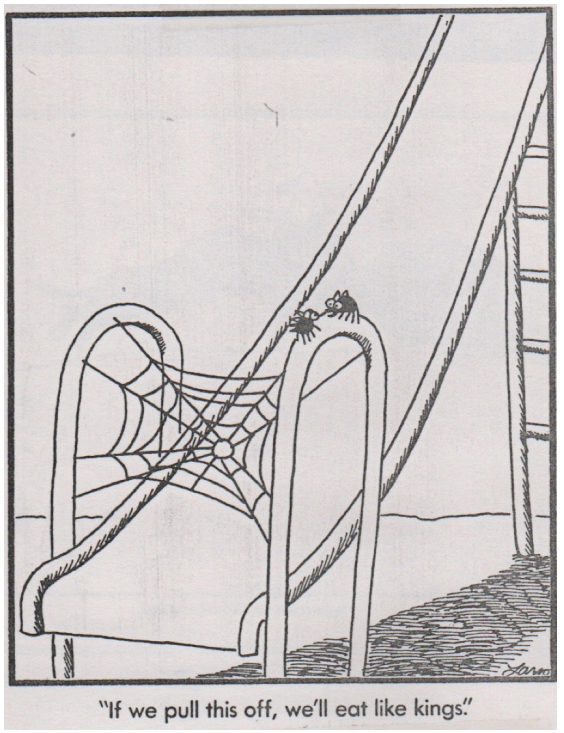

Why predators don't kill all their prey? Because they can't.
"Listen ... I'm fed up with this 'weeding out the sick and the old' business ... I want something in its prime."

Why predators don't kill all their prey? Because they can't.

1 Prey defense



"Testing the carnivore-proof vest"

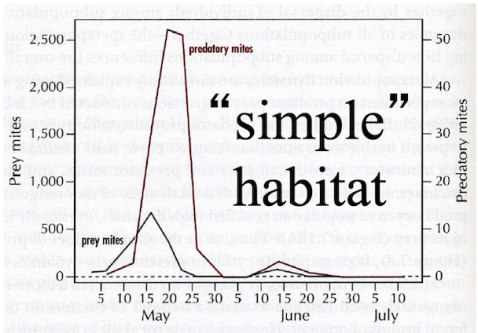


"If we pull this off, we'll eat like kings."

Why predators don't kill all their prey? Because they can't.

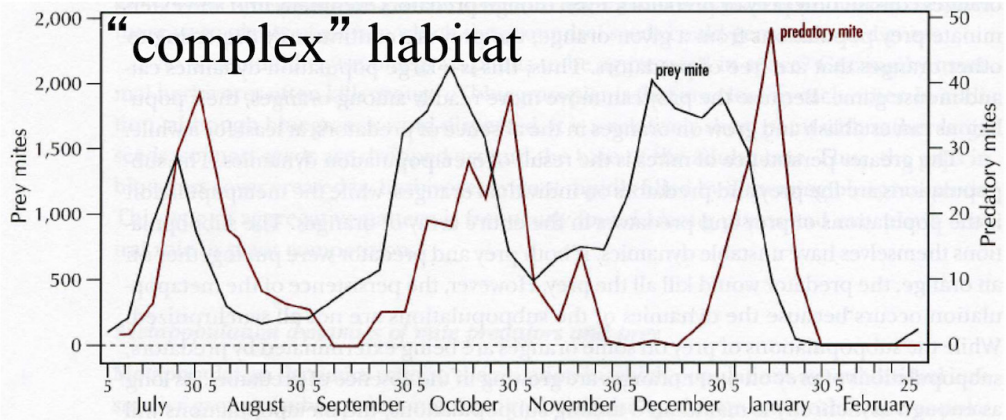
1 Prey defense

2 Complex habitats



Complex habitats are stabilizing

Huffaker 1958



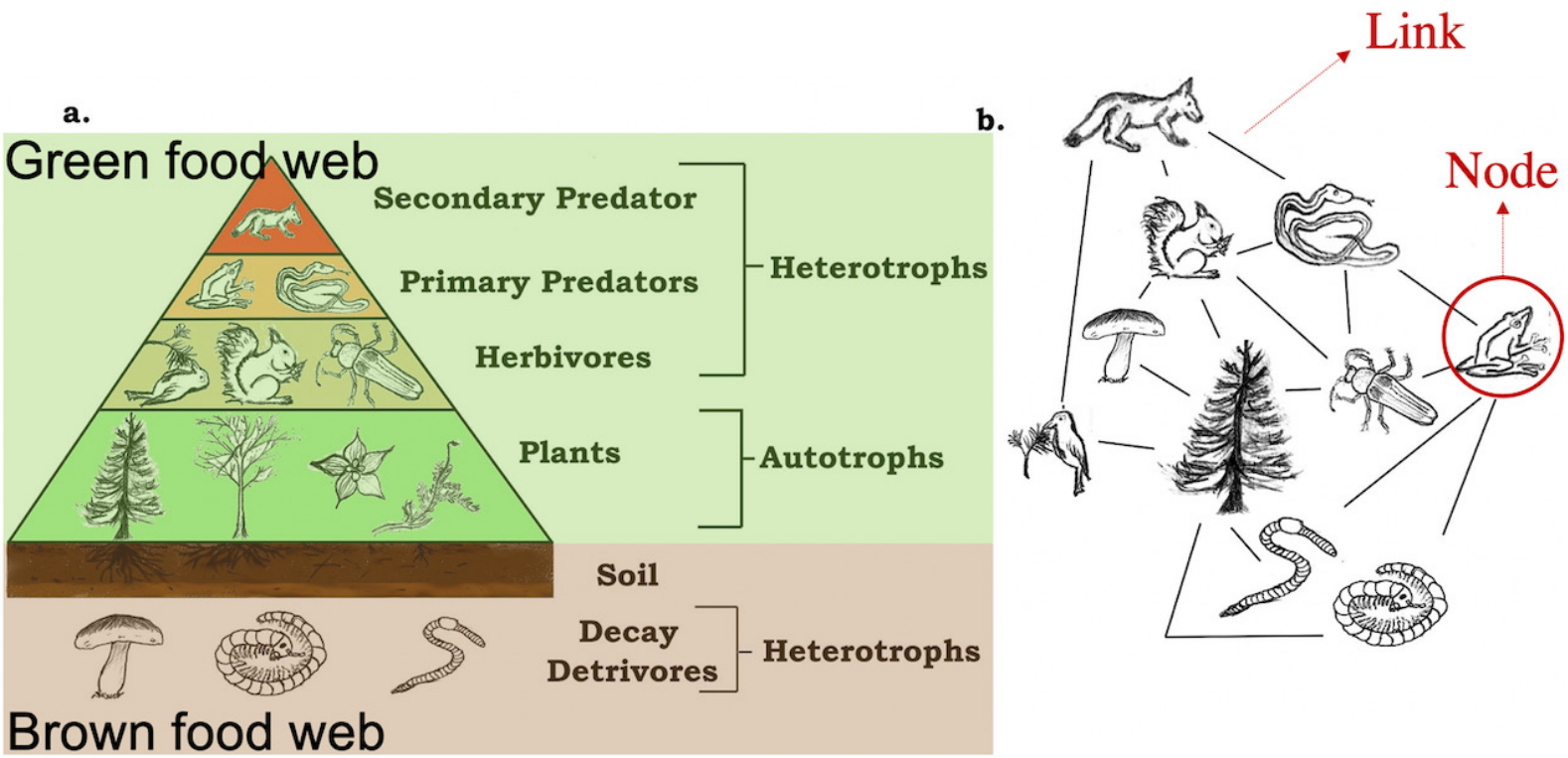
Why predators don't kill all their prey? Because they can't.

1 Prey defense

2 Complex habitats

3 Predators have their own predators

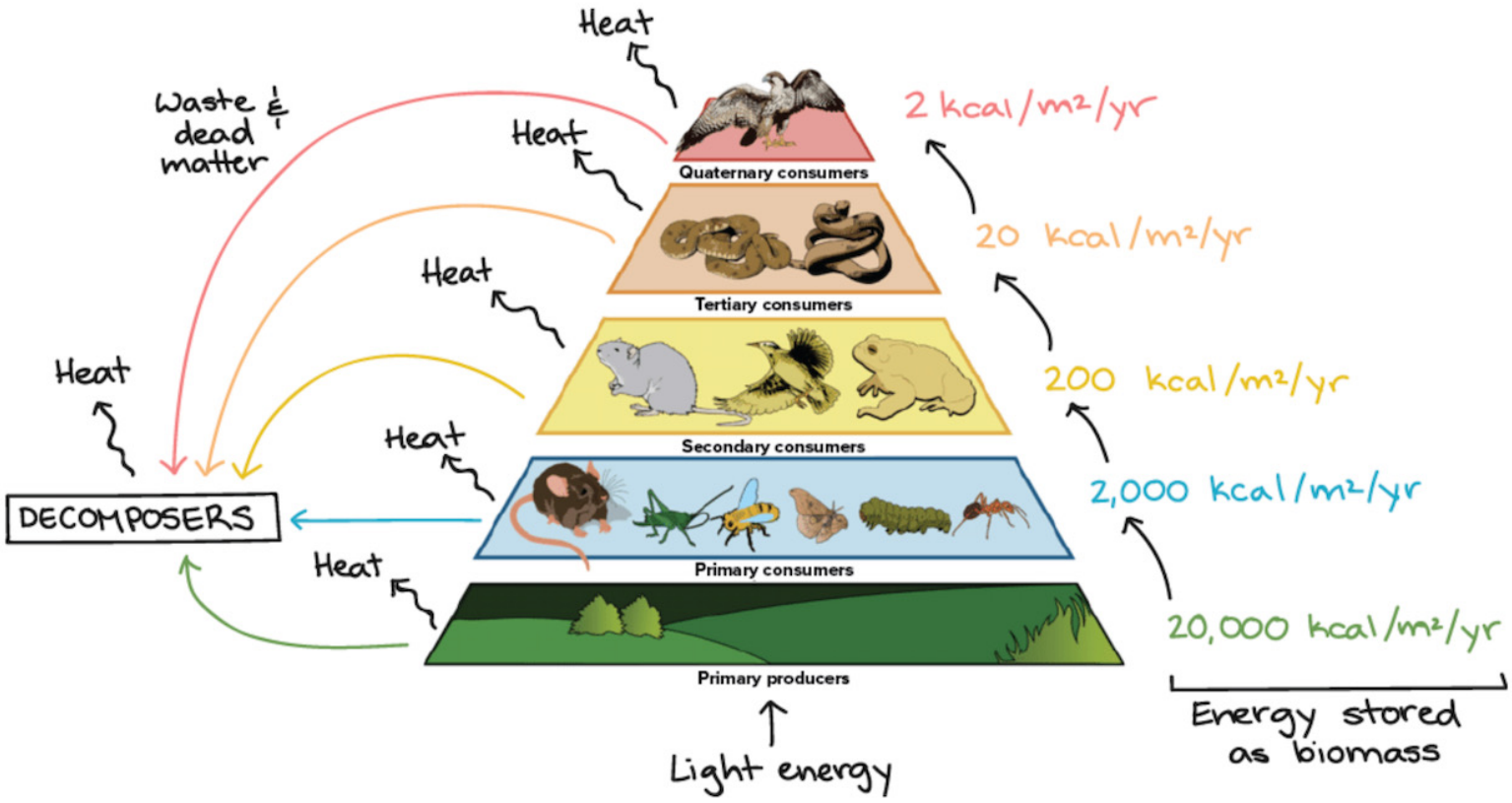
Food web


a.
Green food web
Secondary Predator
Primary Predators
Herbivores
Heterotrophs
Plants
Autotrophs
Soil
Decay
Detrivores
Heterotrophs
Brown food web
b.
Link
Node

Types of food webs

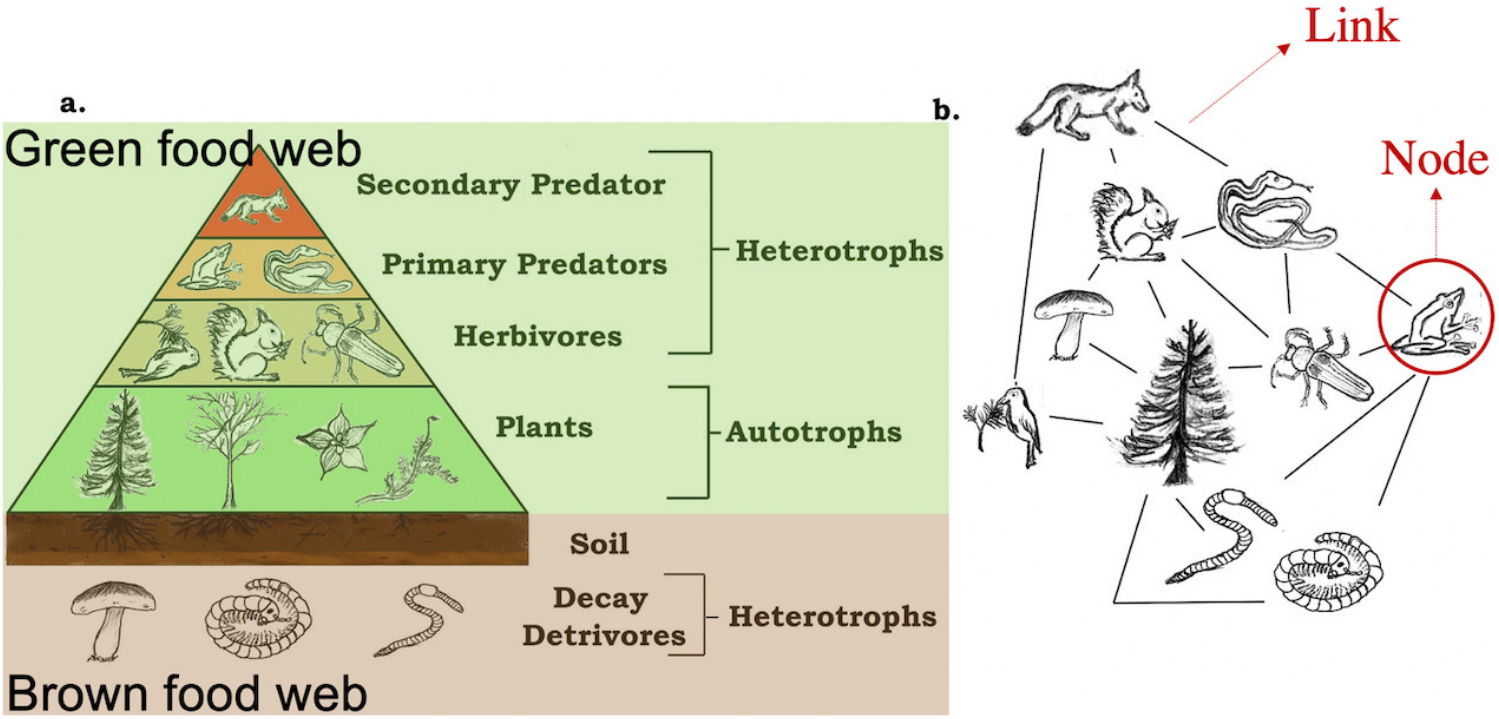
- Connectedness food web
- Energy flow food web
- Functional food web

What controls food webs?



Energy; disturbance; ecosystem size; etc.

Pyramid structure

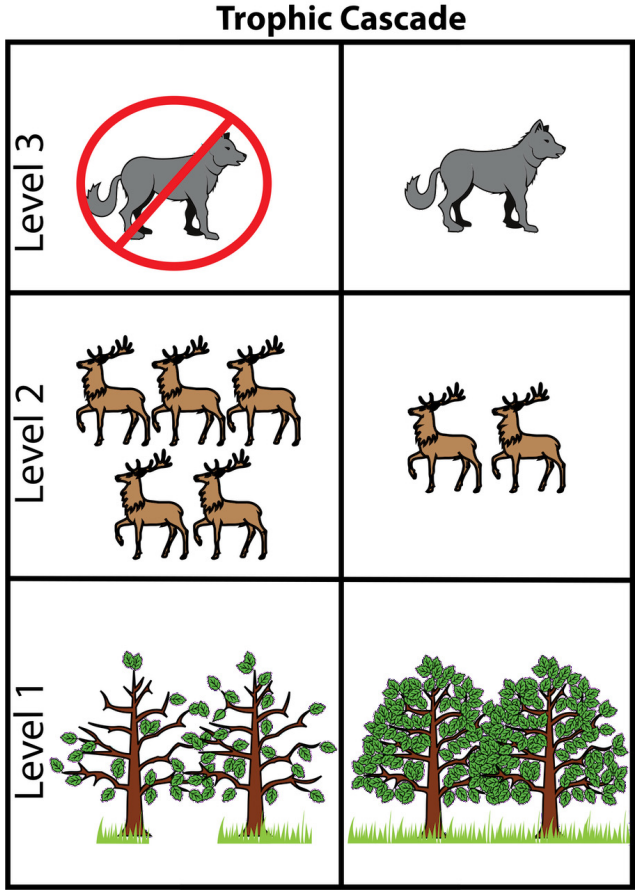


Trophic cascades

Changes in abundances of organisms at one trophic level can influence energy flow at multiple trophic levels

- Top-down
- Bottom-up

Benefits to humans of removing a top predator << damage inflicted by a mesopredator/herbivor that become more abundanct after the top predator declines.



Question

Do clear predator-prey cycles occur frequently in nature?