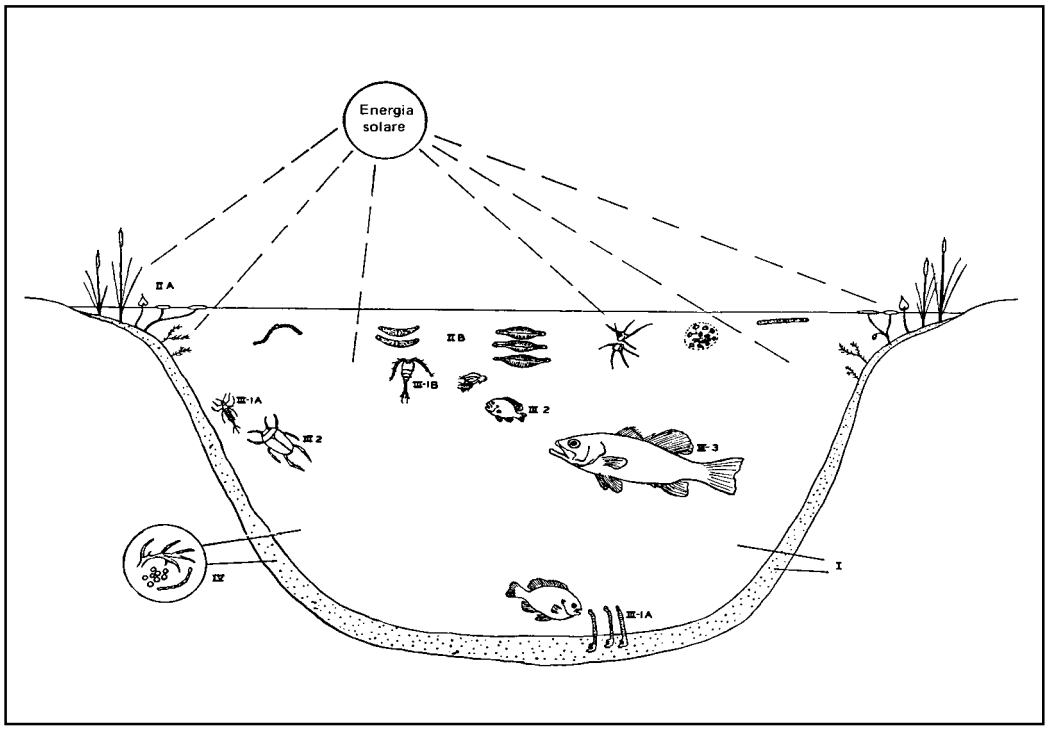


Organismi
autoecologia

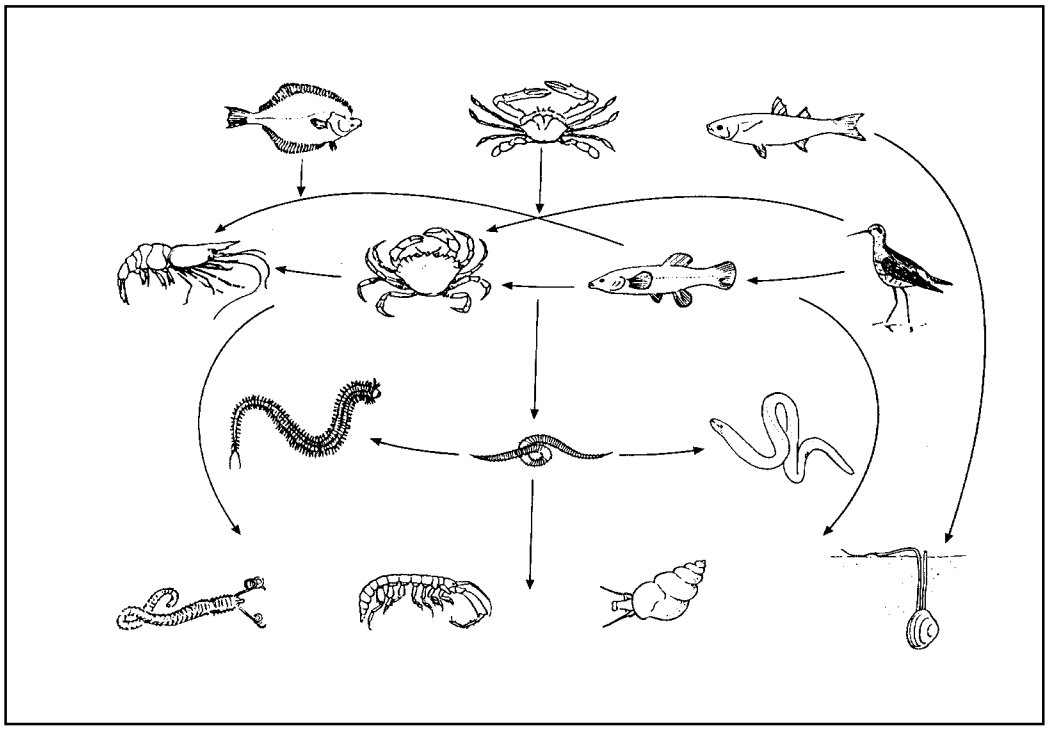
Popolazioni
fattori limitanti

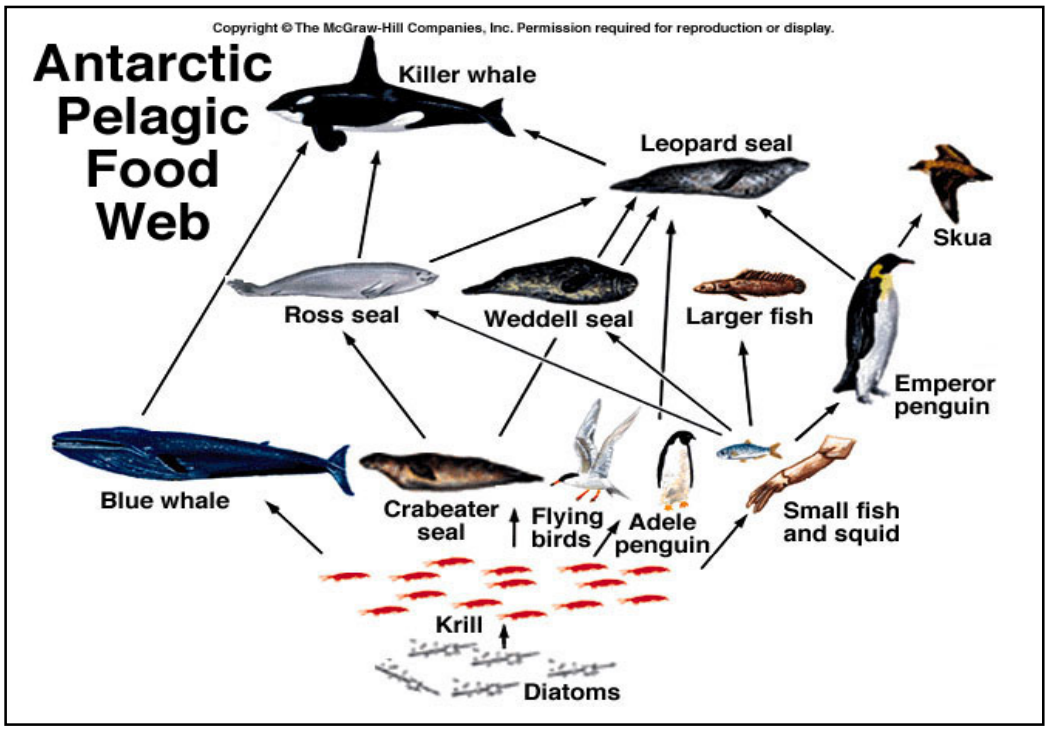
Comunità
interazioni interspecifiche e diversità

Ecosistemi
Flussi di energia e cicli biogeochimici

Ecologia del paesaggio
interazioni fra diversi tipi di ecosistemi

Biosfera
effetti globali

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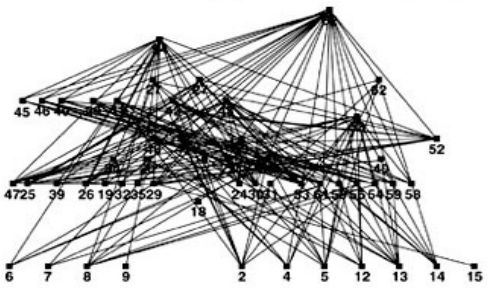
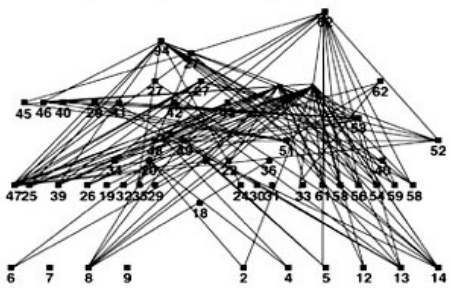
Antarctic Pelagic Food Web
Killer whale
Leopard seal
Skua
Ross seal
Weddell seal
Larger fish
Emperor penguin
Blue whale
Crabeater seal
Flying birds
Adele penguin
Small fish and squid
Krill
Diatoms

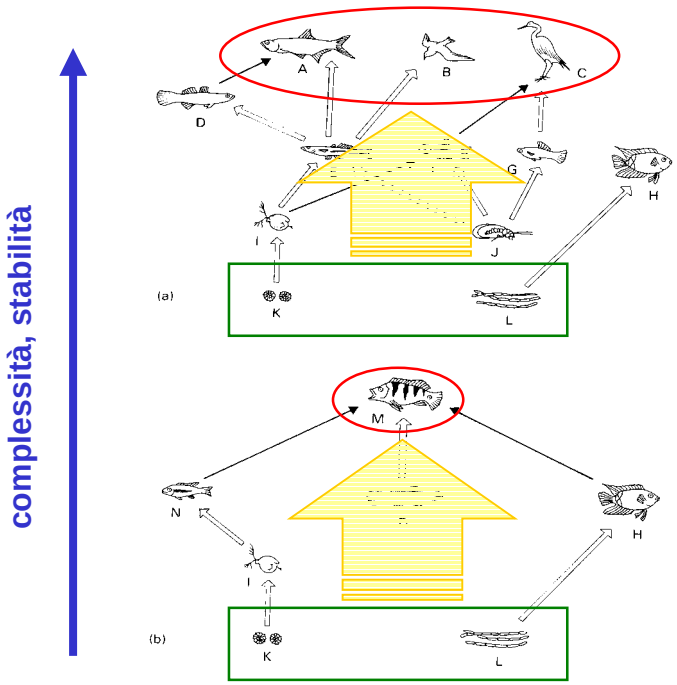
Feeding Relations of Fish





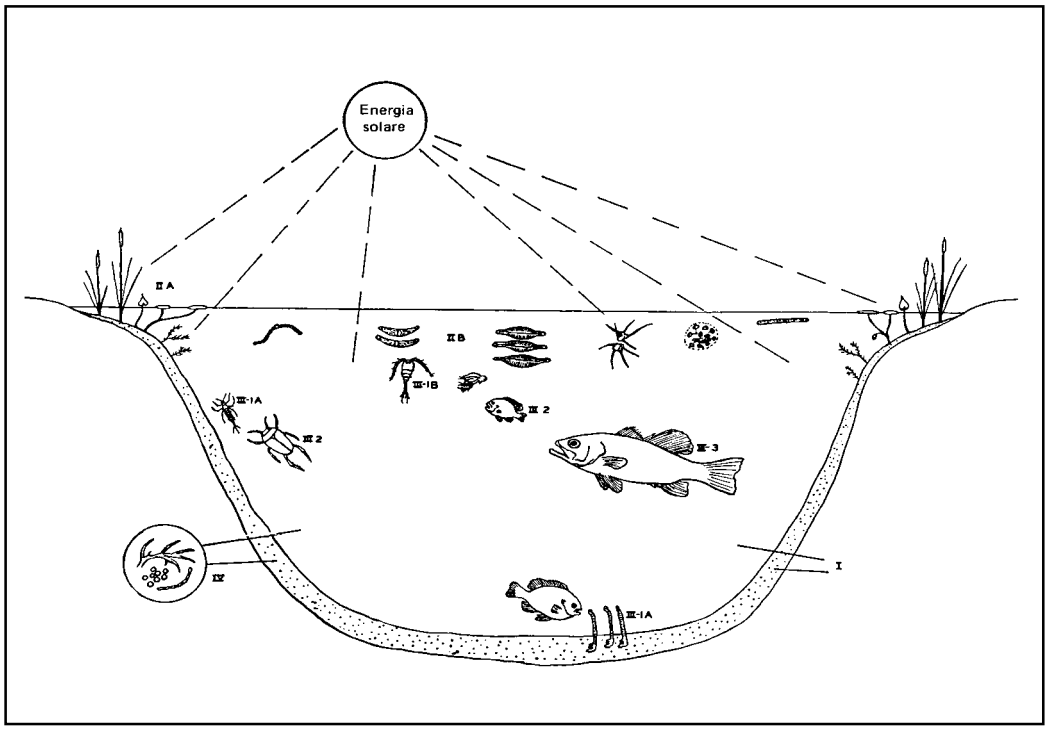
Even a food web with only 10 fish species and their foods can be very complex.

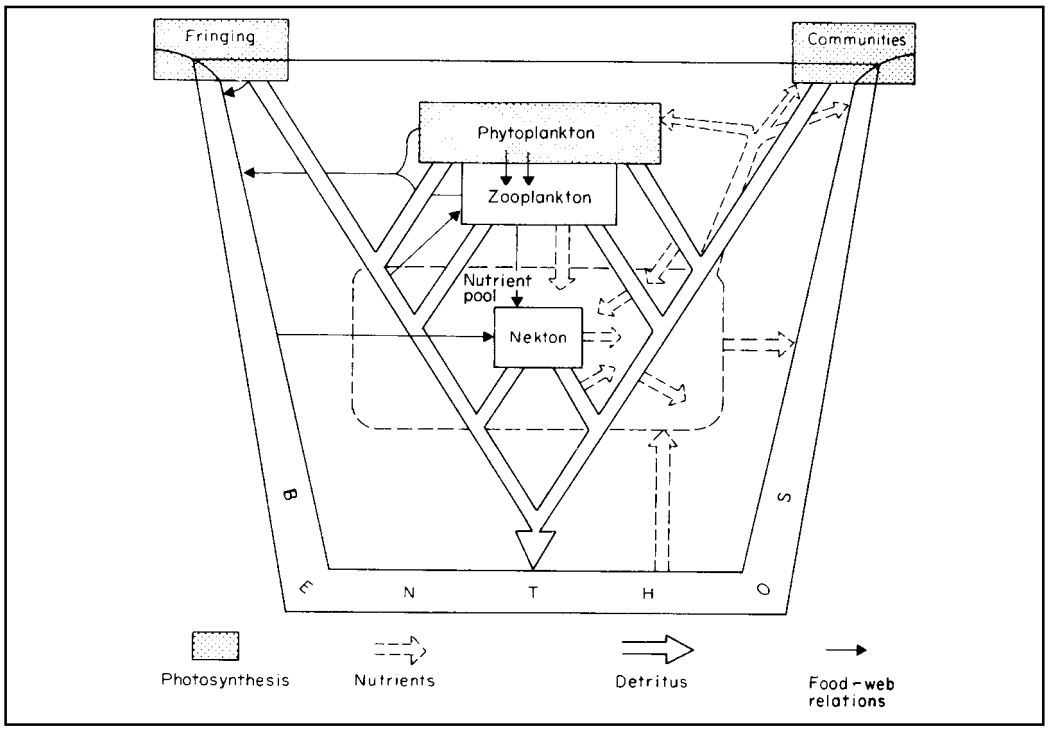
However, removing weak feeding relationships produces a more understandable picture of the community.

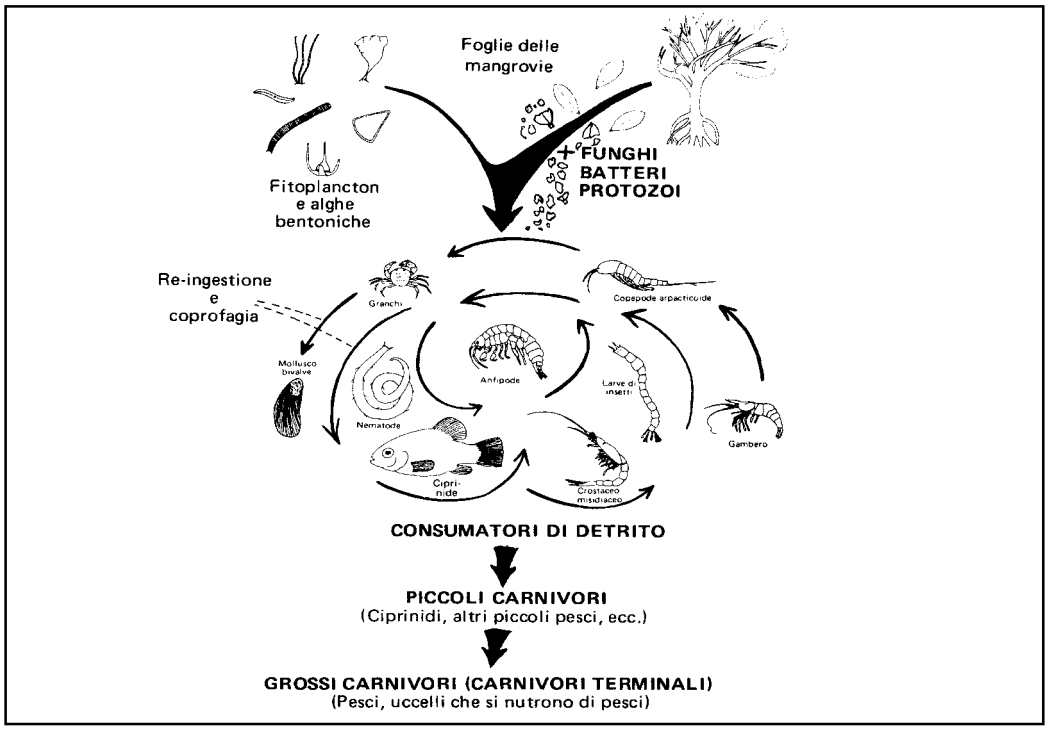


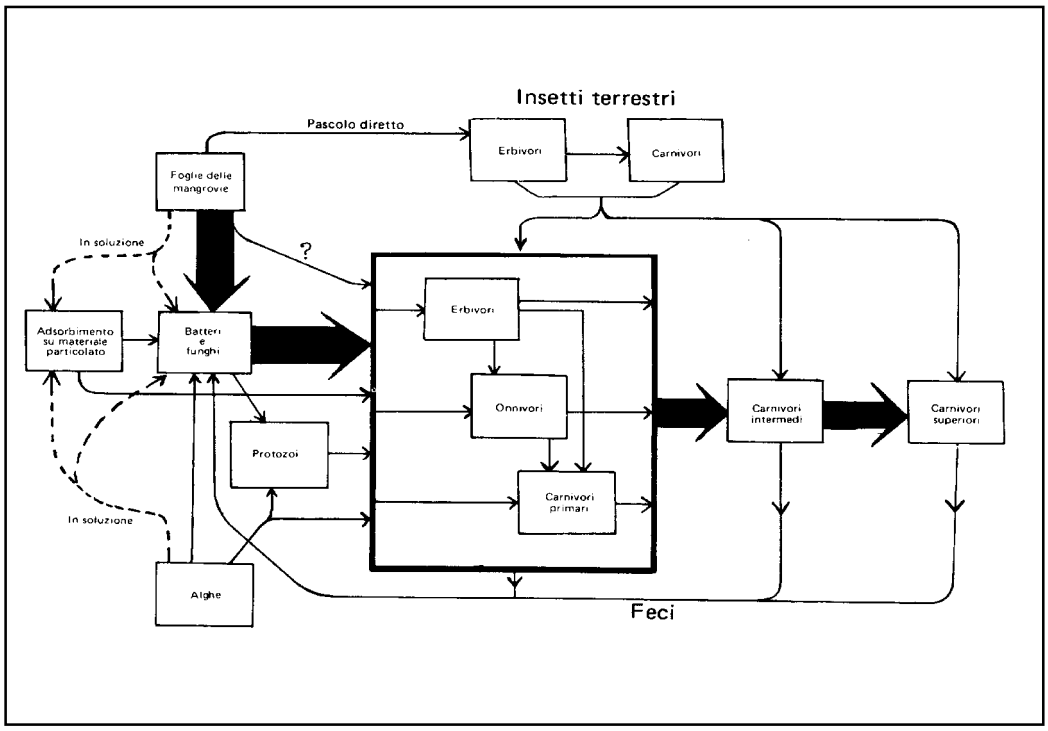
complessità, stabilità

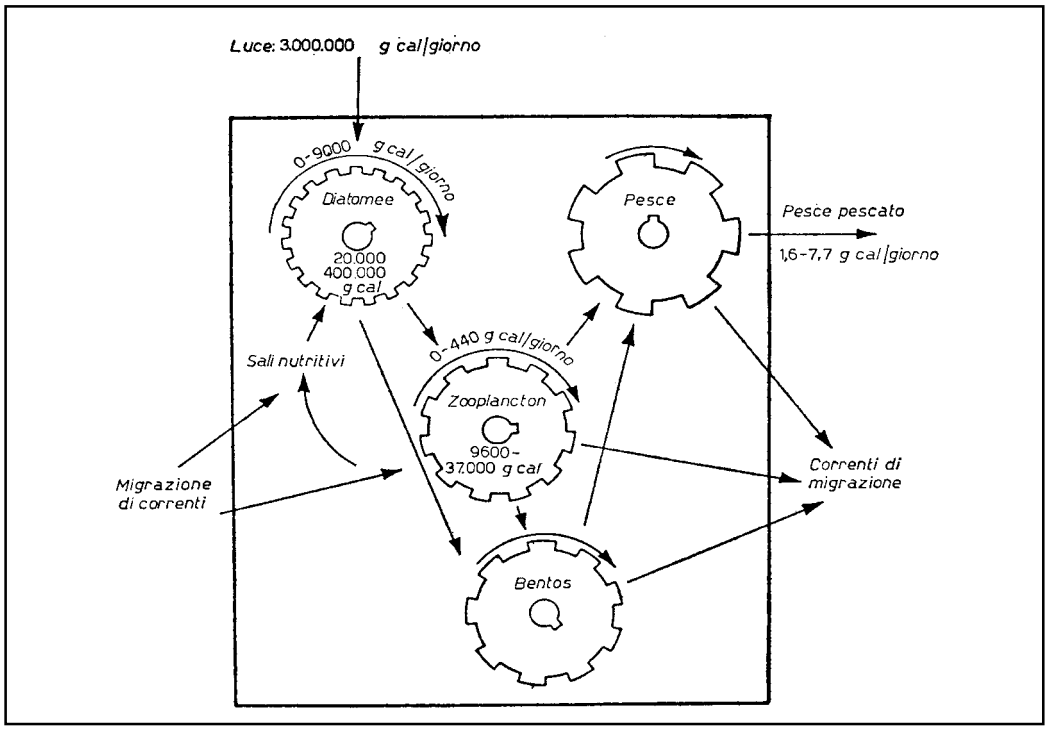
produttività


Energia solare
II A
II B
III-1B
III-1A
III 2
III 2
III-3
IV
I
III-1A


Fringing
Communities
Phytoplankton
Zooplankton
Nutrient pool
Nekton
B
S
E
N
T
H
O
Photosynthesis
Nutrients
Detritus
Food-web relations


Foglie delle mangrovie
+FUNGHI
BATTERI
PROTOZOI
Fitoplancton
e alghe
bentoniche
Re-ingestione
e
coprofagia
Granchi
Copepode arpacticoide
Mollusco bivalve
Anfipode
Larve di insetti
Nematode
Gambero
Ciprinide
Crostaceo misidiaceo
CONSUMATORI DI DETRITO
PICCOLI CARNIVORI
(Ciprinidi, altri piccoli pesci, ecc.)
GROSSI CARNIVORI (CARNIVORI TERMINALI)
(Pesci, uccelli che si nutrono di pesci)


Insetti terrestri
Pascolo diretto
Erbivori
Carnivori
Foglie delle mangrovie
In soluzione
?
Adsorbimento su materiale particolato
Batteri e funghi
Erbivori
Onnivori
Carnivori primari
Carnivori intermedi
Carnivori superiori
Protozoi
In soluzione
Alghe
Feci

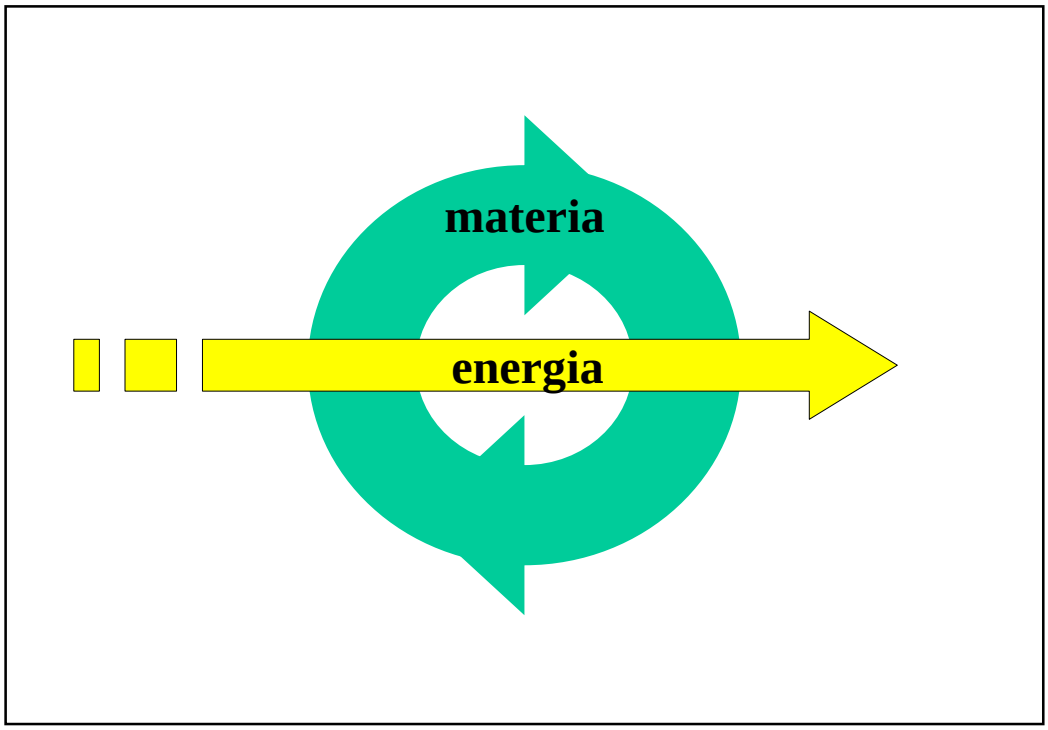


Prima legge della termodinamica

L'energia si conserva: non può essere nè creata nè distrutta, ma solo trasformata.

Seconda legge della termodinamica

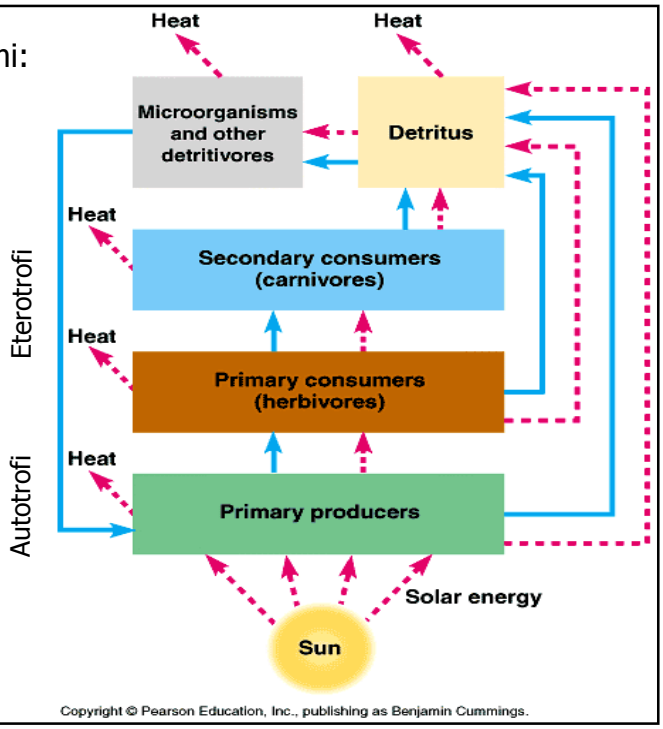
Le trasformazioni dell'energia non sono mai completamente efficienti: esse comportano una parziale dissipazione sotto forma di calore (l'entropia dell'universo è costantemente in aumento).

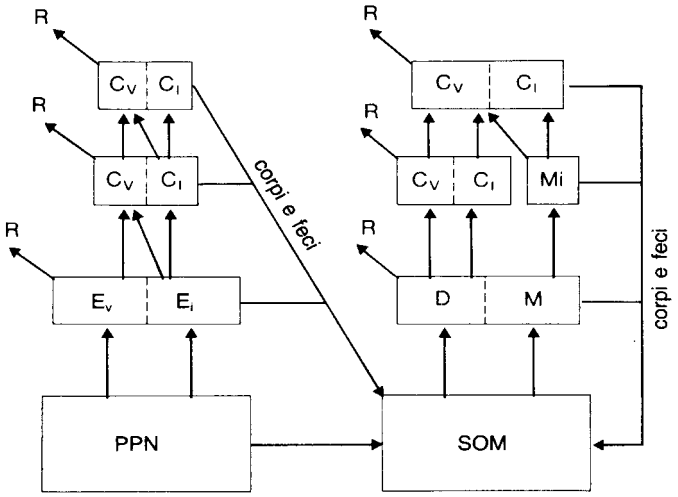


Dinamica degli ecosistemi:
1- Flussi di energia
2- Cicli biogeochimici

ENERGIA – Non puo' essere riciclata, fluisce attraverso gli ecosistemi, proviene da una fonte esterna. Entra come luce ed esce come calore.

MATERIA – Circola all'interno degli ecosistemi.

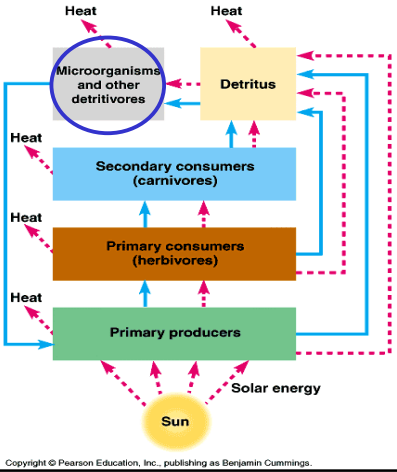


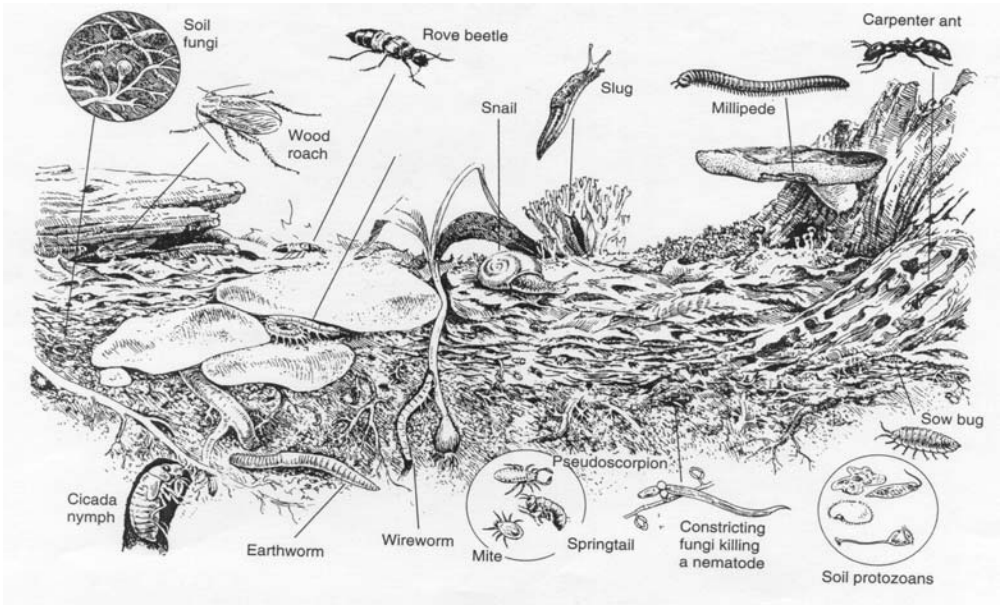


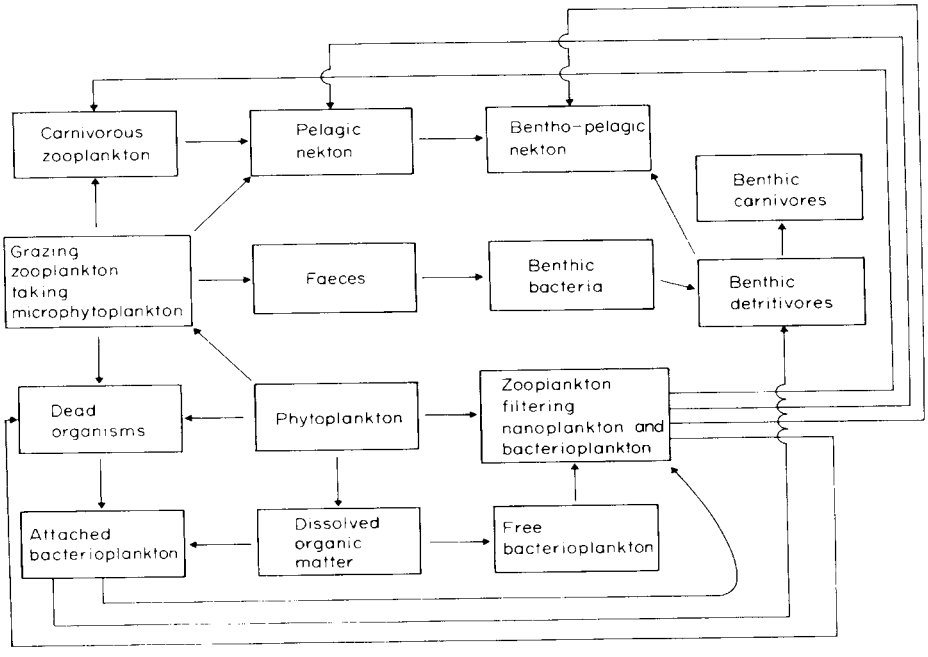
v vertebrato
i invertebrato
PPN produzione primaria netta
SOM sostanza organica morta
E erbivoro
C carnivoro
D detritivoro
M microrganismi
Mi microbivoro

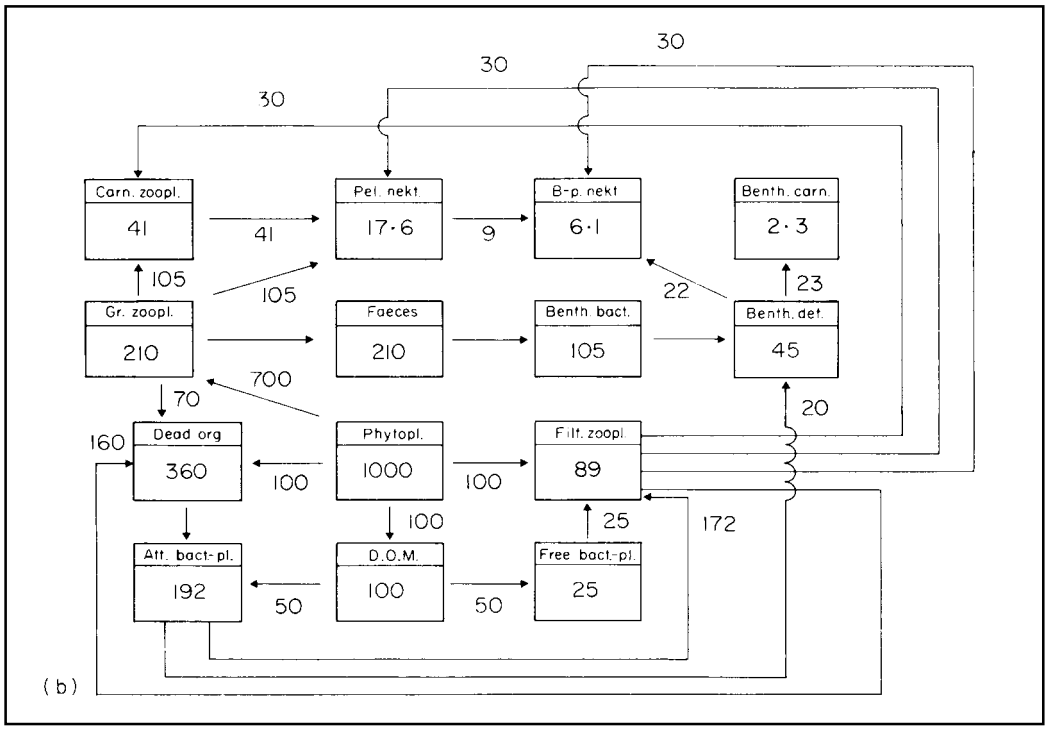
Interconnessioni fra livelli trofici:

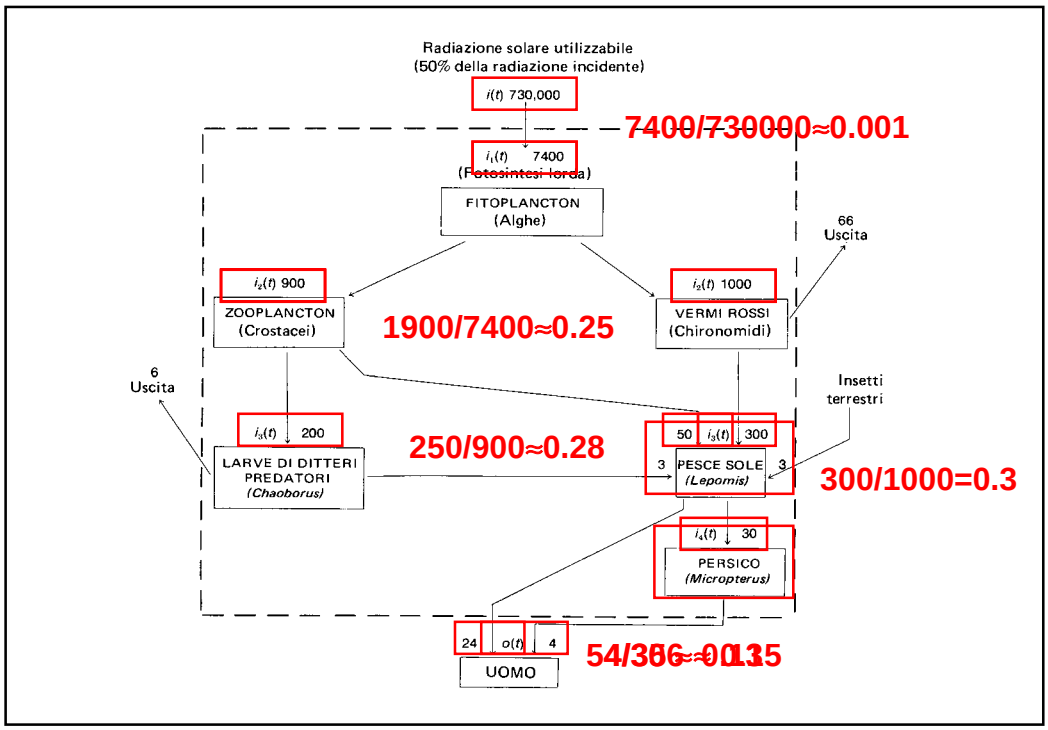
- Tutti i livelli trofici sono connessi fra loro attreverso i decompositori.
- Batteri e funghi riciclano gli elementi che costituiscono la materia organica, decomponendola.
- Senza decomposizione non ci sarebbe vita.

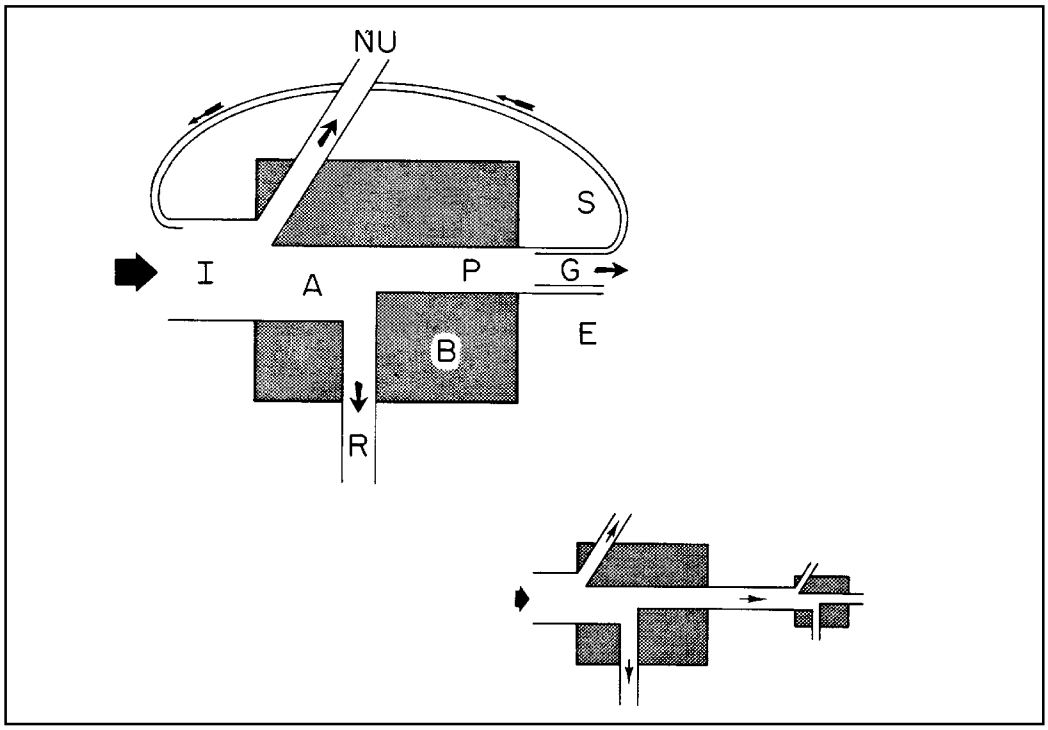


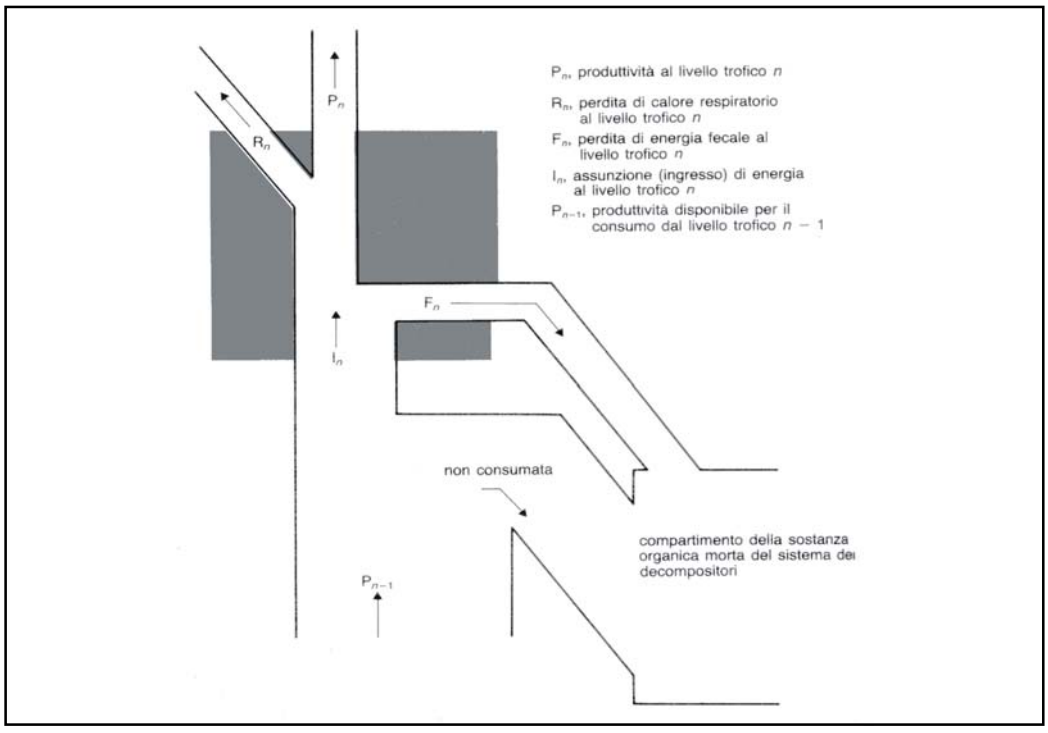

Soil fungi
Rove beetle
Carpenter ant
Slug
Snail
Millipede
Wood roach
Sow bug
Pseudoscorpion
Cicada nymph
Earthworm
Wireworm
Mite
Springtail
Constricting fungi killing a nematode
Soil protozoans

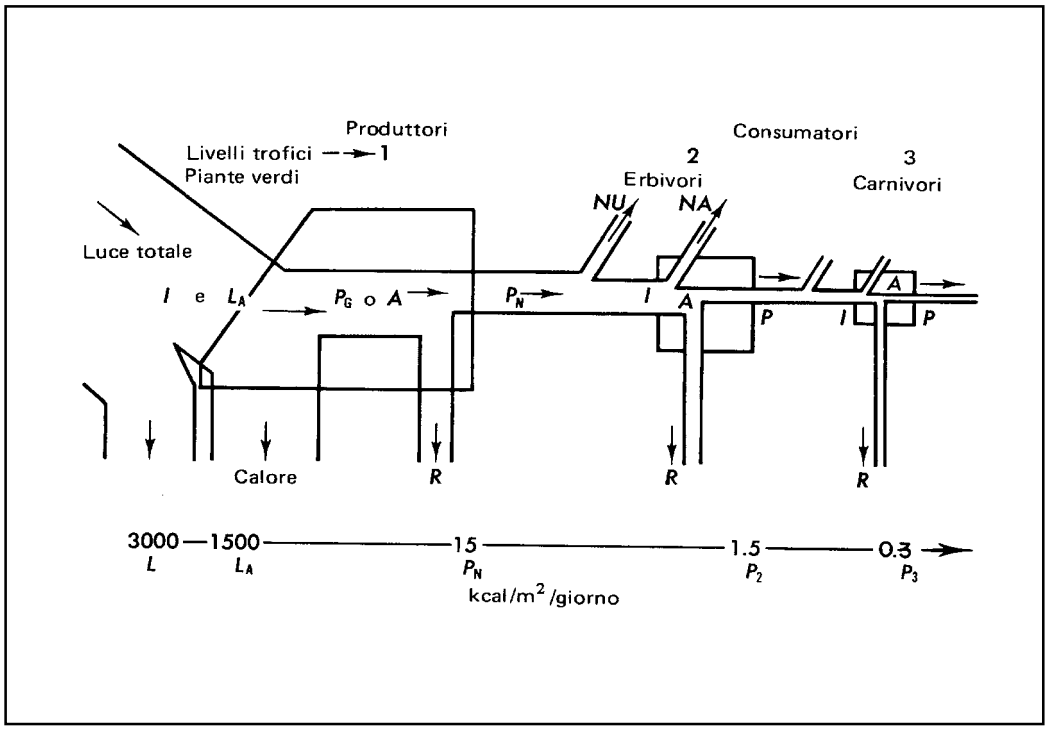

Carnivorous zooplankton
Pelagic nekton
Bentho-pelagic nekton
Benthic carnivores
Grazing zooplankton taking microphytoplankton
Faeces
Benthic bacteria
Benthic detritivores
Dead organisms
Phytoplankton
Zooplankton filtering nanoplankton and bacterioplankton
Attached bacterioplankton
Dissolved organic matter
Free bacterioplankton

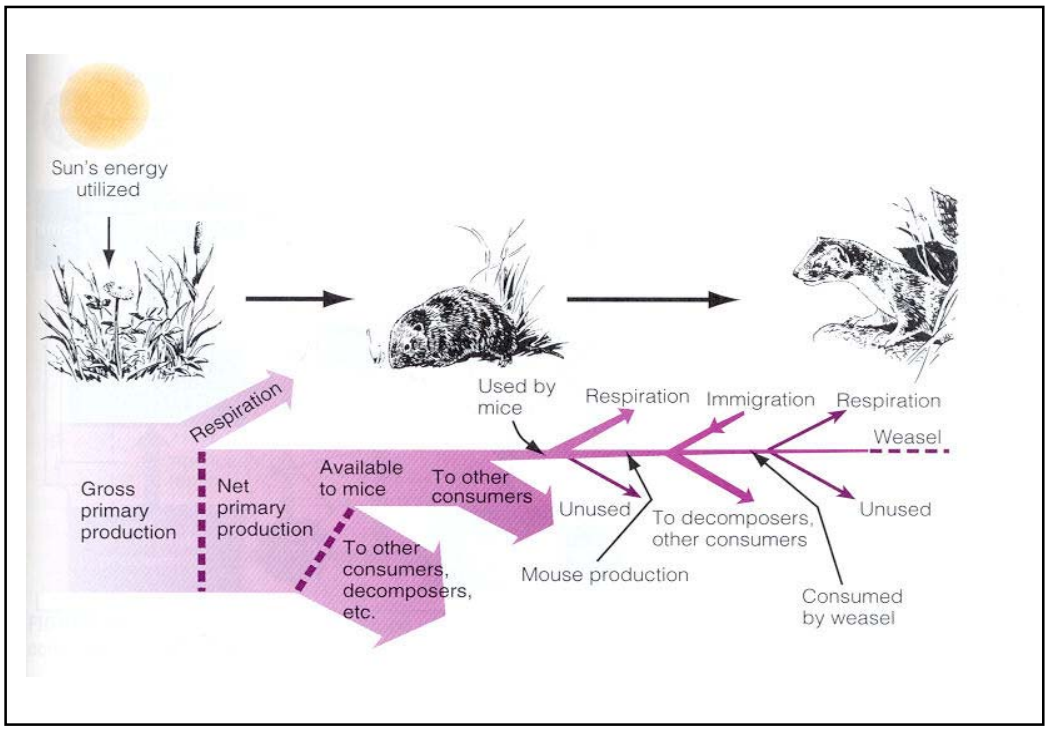

30
30
30
Carn. zoopl.
41
41
Pel. nekt.
17·6
9
B-p. nekt
6·1
Benth. carn.
2·3
105
105
22
23
Gr. zoopl.
210
Faeces
210
Benth. bact.
105
Benth. det.
45
700
70
20
160
Dead org
360
100
Phytopl.
1000
100
Filt. zoopl
89
100
25
172
Aff. bact-pl.
192
50
D.O.M.
100
50
Free bact.-pl.
25
(b)


Radiazione solare utilizzabile
(50% della radiazione incidente)
i(t) 730,000
7400/730000≈0.001
i1(t) 7400
(Fotosintesi lorda)
FITOPLANCTON
(Alghe)
66
Uscita
i2(t) 900
ZOOPLANCTON
(Crostacei)
1900/7400≈0.25
i5(t) 1000
VERMI ROSSI
(Chironomidi)
6
Uscita
Insetti
terrestri
i3(t) 200
LARVE DI DITTERI
PREDATORI
(Chaoborus)
250/900≈0.28
50
i5(t) 300
3
PESCE SOLE
(Lepomis)
3
300/1000=0.3
i4(t) 30
PERSICO
(Micropterus)
24
o(t)
4
UOMO
54/366≈0.15

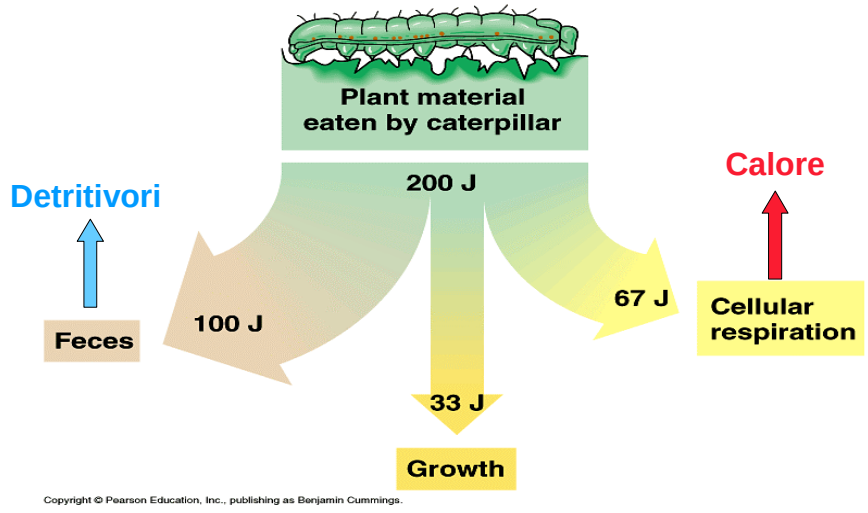

NU
S
I
A
P
G
E
B
R

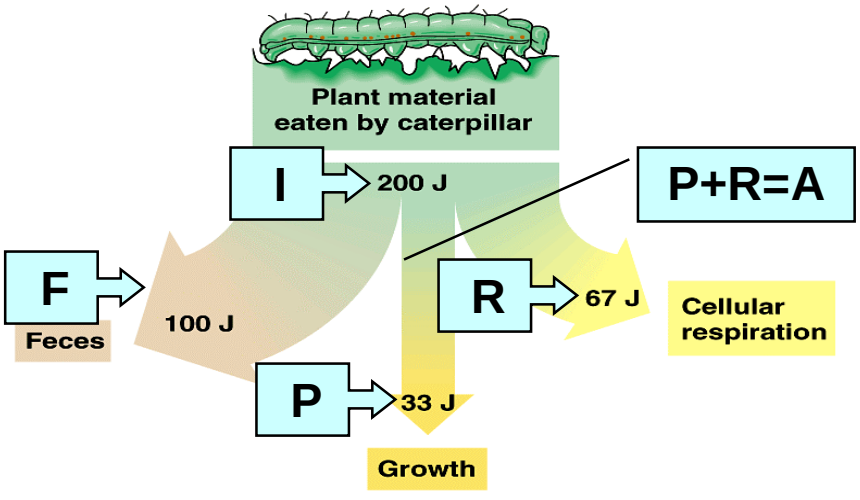

P_n, produttività al livello trofico n
R_n, perdita di calore respiratorio al livello trofico n
F_n, perdita di energia fecale al livello trofico n
I_n, assunzione (ingresso) di energia al livello trofico n
P_{n-1}, produttività disponibile per il consumo dal livello trofico $n-1$
P_n
R_n
F_n
I_n
non consumata
compartimento della sostanza organica morta del sistema dei decompositori
P_{n-1}


Produttori
Livelli trofici → 1
Piante verdi
Consumatori
2
Erbivori
3
Carnivori
NU
NA
Luce totale
I e L_A
P_G o A
P_N
I
A
P
I
A
P
Calore
R
R
R
3000 — 1500 — 15 — 1.5 — 0.3 →
L
L_A
P_N
P_2
P_3
kcal/m² /giorno


Sun's energy utilized
Respiration
Used by mice
Respiration
Immigration
Respiration
Weasel
Gross primary production
Net primary production
Available to mice
To other consumers
Unused
To decomposers, other consumers
Unused
To other consumers, decomposers, etc.
Mouse production
Consumed by weasel

Produzione secondaria



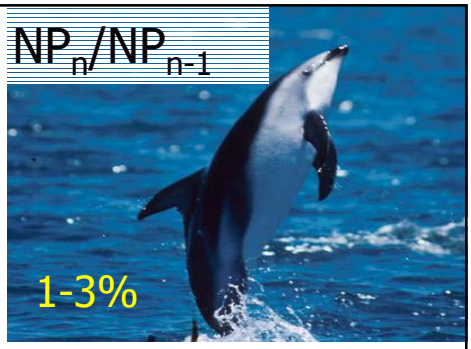


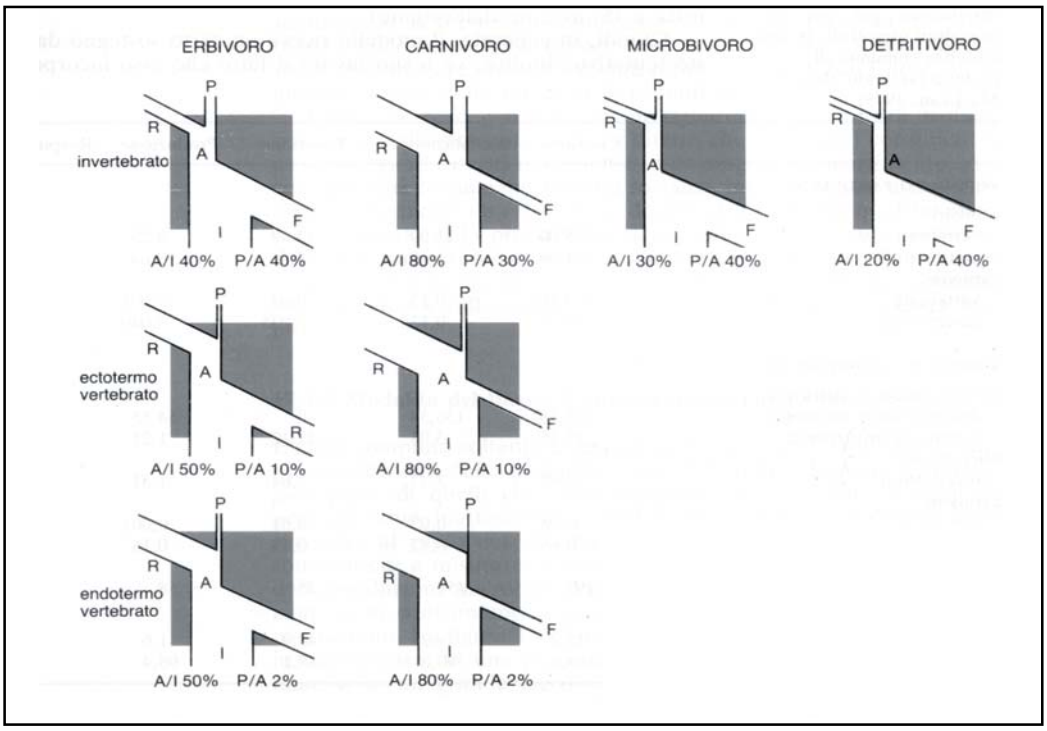
Rendimento di consumo: $RC=I_n/P_{n-1}$

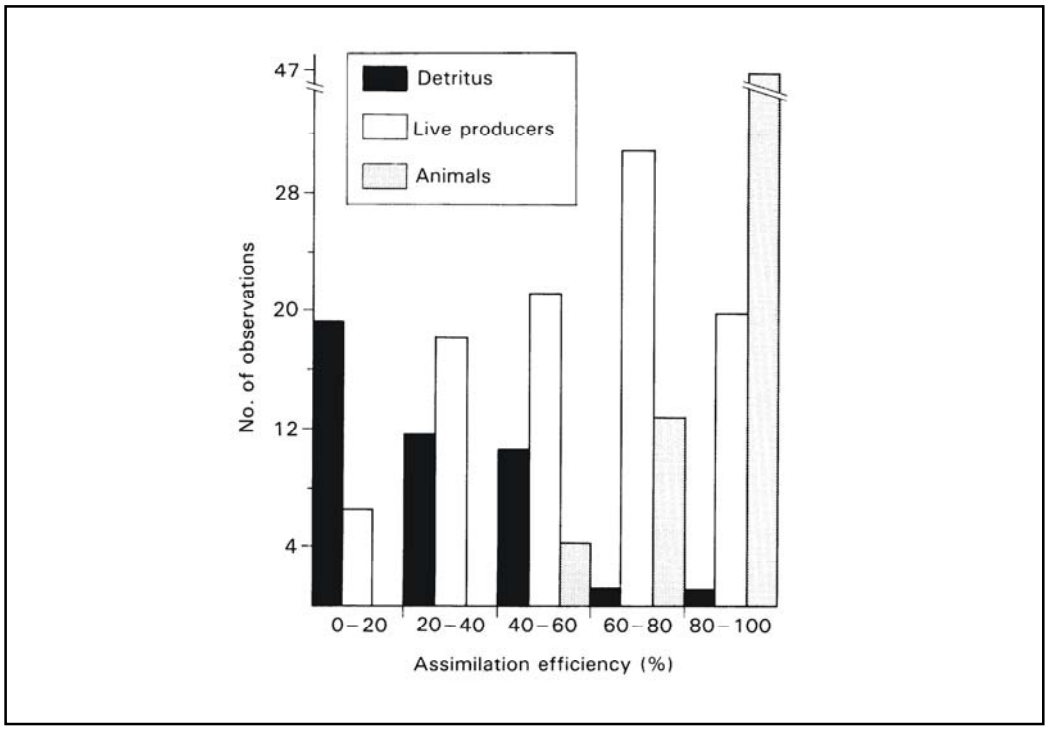
Rendimento di assimilazione: $RA=A_n/I_n$

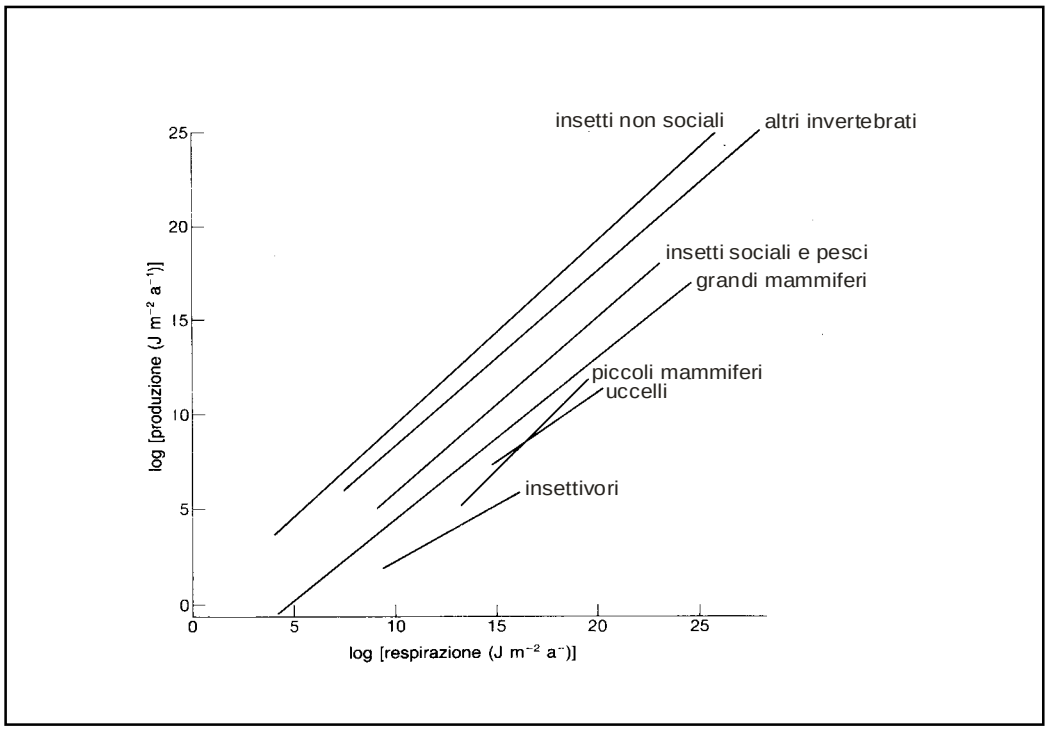
Rendimento di produzione: $RP=P_n/A_n$

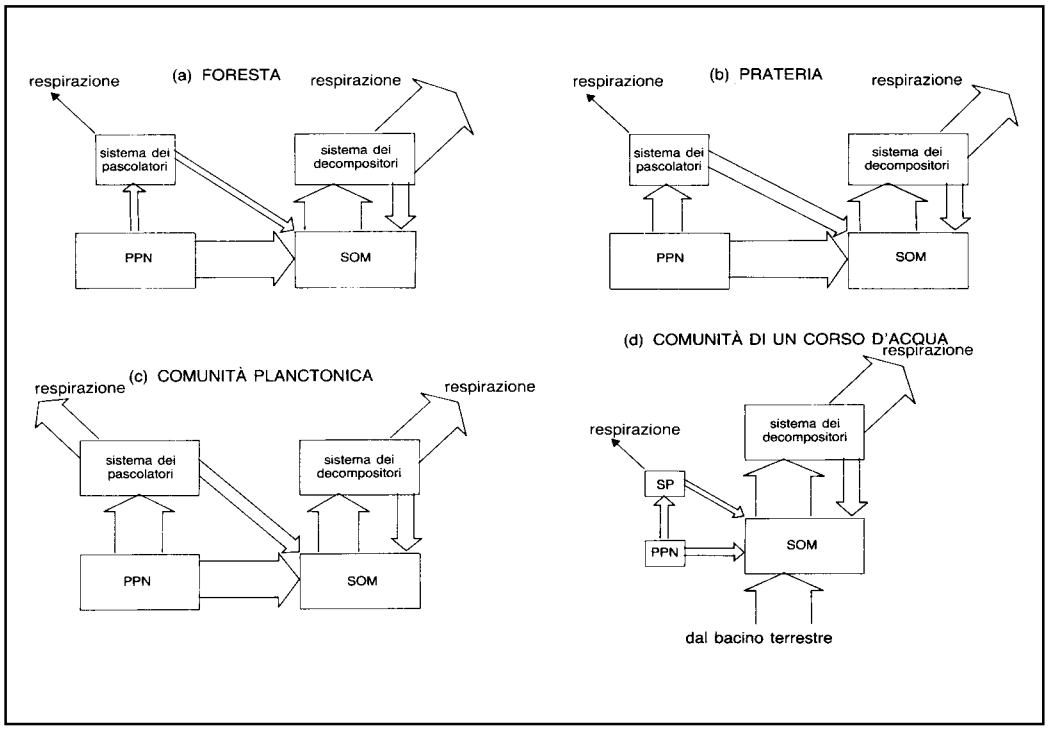
Efficienza ecologica: NP_n/NP_{n-1}

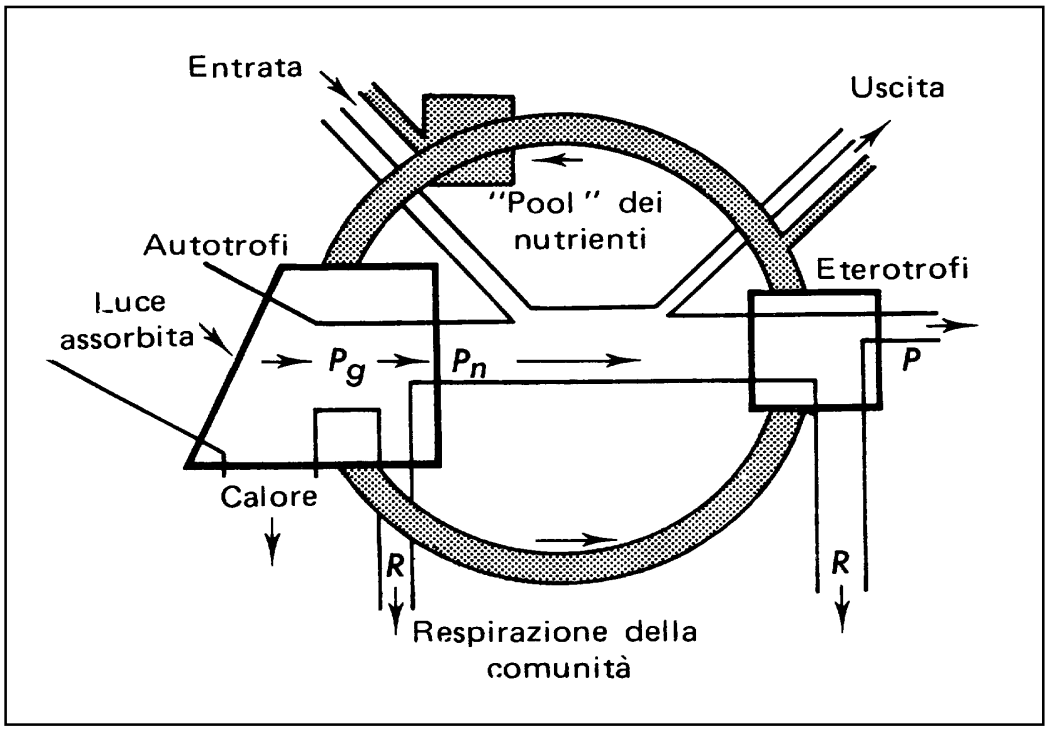


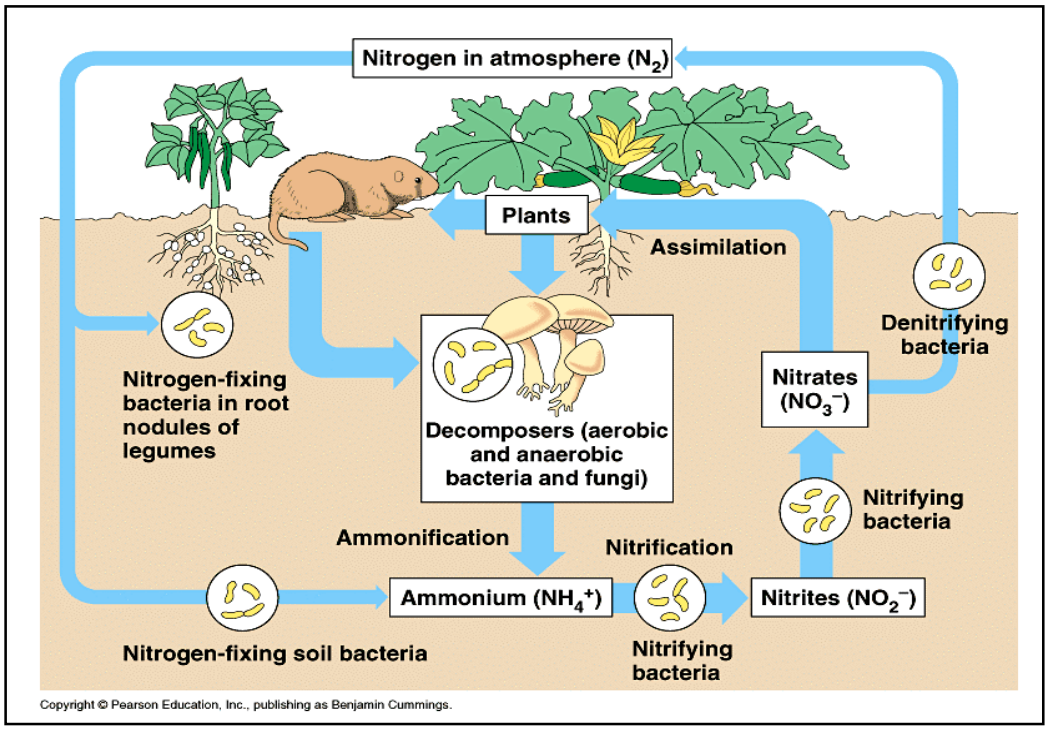



47
28
20
12
4
Detritus
Live producers
Animals
No. of observations
0–20
20–40
40–60
60–80
80–100
Assimilation efficiency (%)


insetti non sociali
altri invertebrati
insetti sociali e pesci
grandi mammiferi
piccoli mammiferi
uccelli
insettivori
log [produzione (J m⁻² a⁻¹)]
log [respirazione (J m⁻² a⁻¹)]
0
5
10
15
20
25


(a) FORESTA
respirazione
respirazione
sistema dei pascolatori
sistema dei decompositori
PPN
SOM
(b) PRATERIA
respirazione
respirazione
sistema dei pascolatori
sistema dei decompositori
PPN
SOM
(c) COMUNITÀ PLANCTONICA
respirazione
respirazione
sistema dei pascolatori
sistema dei decompositori
PPN
SOM
(d) COMUNITÀ DI UN CORSO D'ACQUA
respirazione
respirazione
sistema dei decompositori
SP
PPN
SOM
dal bacino terrestre


Entrata
Uscita
"Pool" dei nutrienti
Autotrofi
Eterotrofi
Luce assorbita
P_g
P_n
P
Calore
R
R
Respirazione della comunità


Nitrogen in atmosphere (N_2)
Plants
Assimilation
Denitrifying bacteria
Nitrogen-fixing bacteria in root nodules of legumes
Decomposers (aerobic and anaerobic bacteria and fungi)
Nitrates (NO_3^-)
Nitrifying bacteria
Ammonification
Nitrification
Ammonium (NH_4^+)
Nitrites (NO_2^-)
Nitrogen-fixing soil bacteria
Nitrifying bacteria
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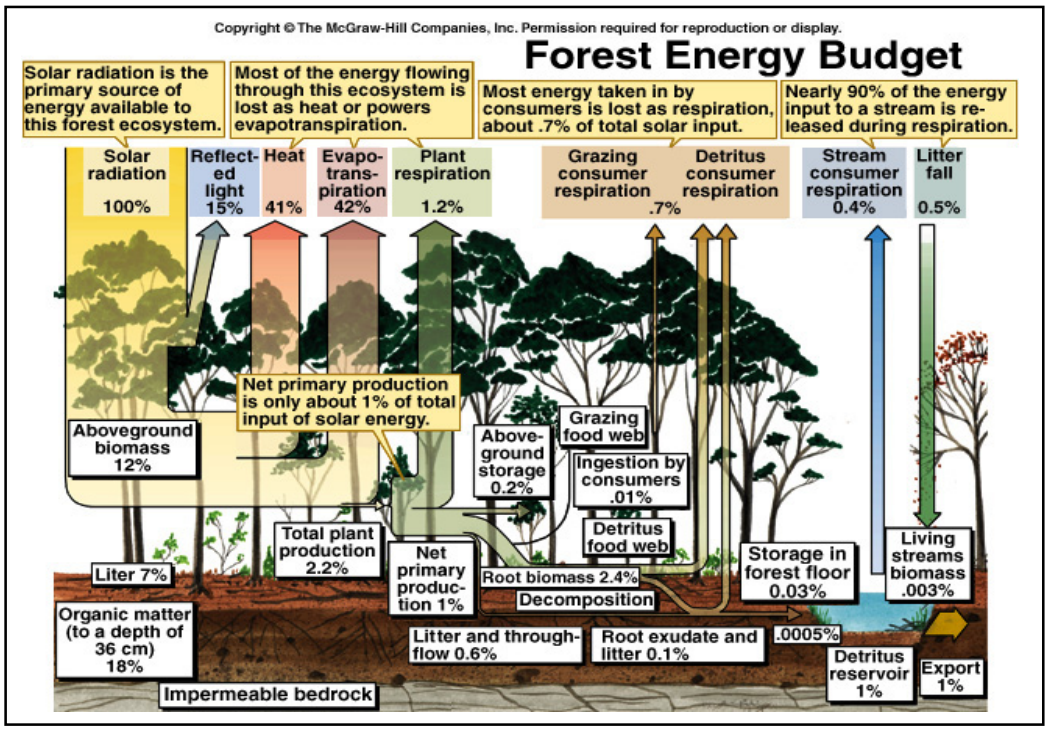
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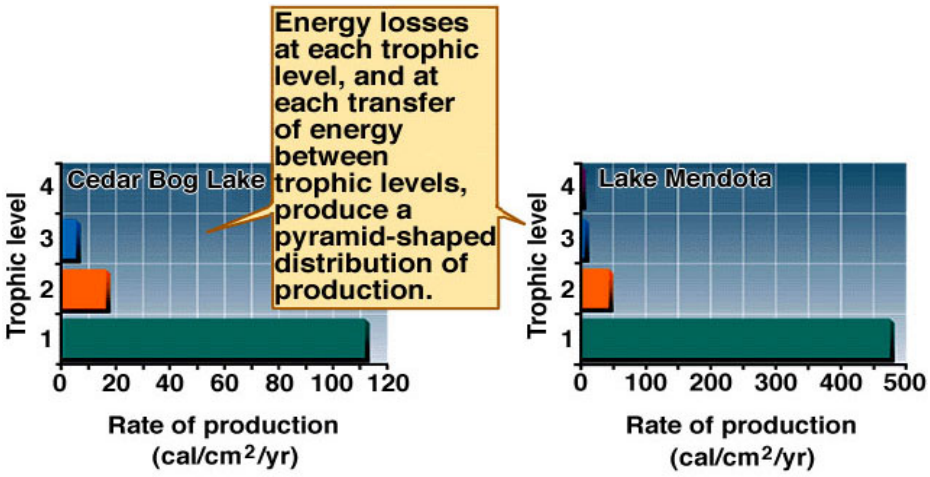
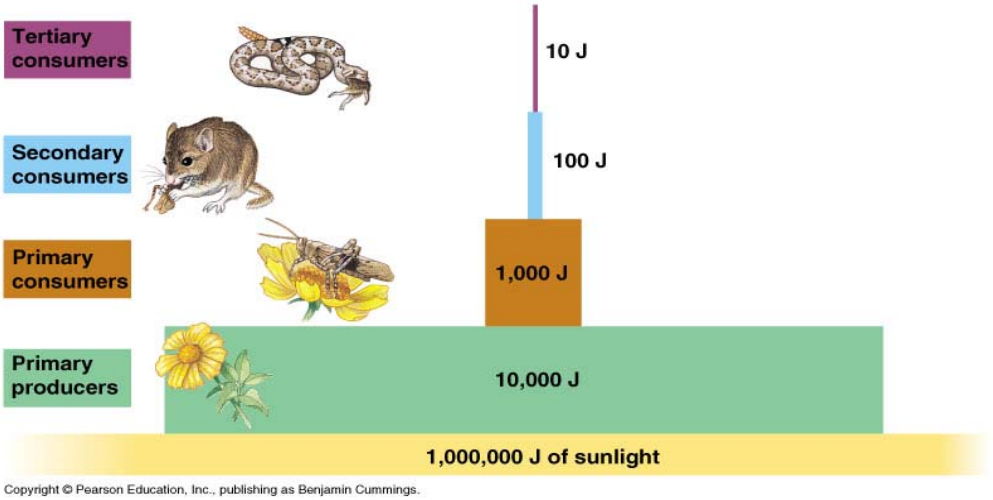
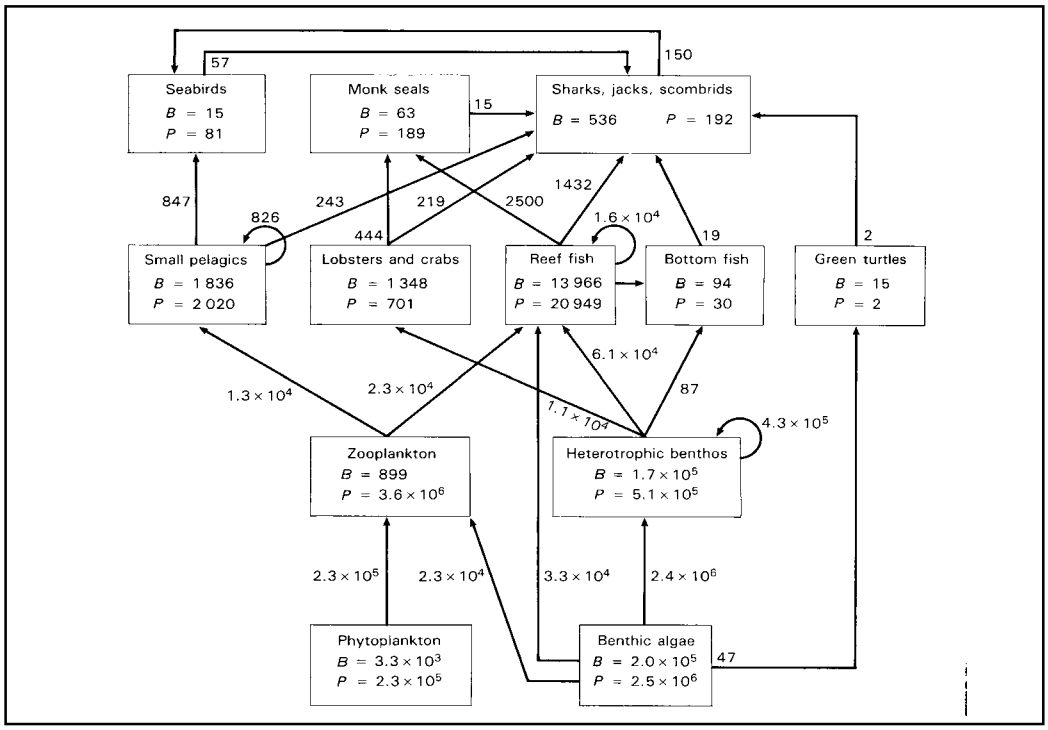
Forest Energy Budget
Solar radiation is the primary source of energy available to this forest ecosystem.
Most of the energy flowing through this ecosystem is lost as heat or powers evapotranspiration.
Most energy taken in by consumers is lost as respiration, about .7% of total solar input.
Nearly 90% of the energy input to a stream is released during respiration.
Solar radiation 100%
Reflected light 15%
Heat 41%
Evapotranspiration 42%
Plant respiration 1.2%
Grazing consumer respiration
Detritus consumer respiration .7%
Stream consumer respiration 0.4%
Litter fall 0.5%
Net primary production is only about 1% of total input of solar energy.
Aboveground biomass 12%
Aboveground storage 0.2%
Grazing food web
Ingestion by consumers .01%
Detritus food web
Total plant production 2.2%
Net primary production 1%
Root biomass 2.4%
Decomposition
Storage in forest floor 0.03%
Living streams biomass .003%
Liter 7%
Organic matter (to a depth of 36 cm) 18%
Litter and throughflow 0.6%
Root exudate and litter 0.1%
.0005%
Detritus reservoir 1%
Export 1%
Impermeable bedrock

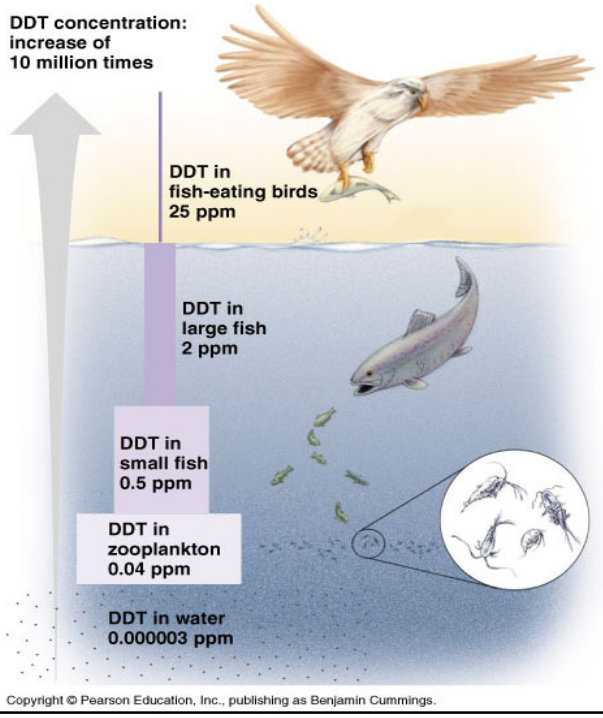
Production by Trophic Level

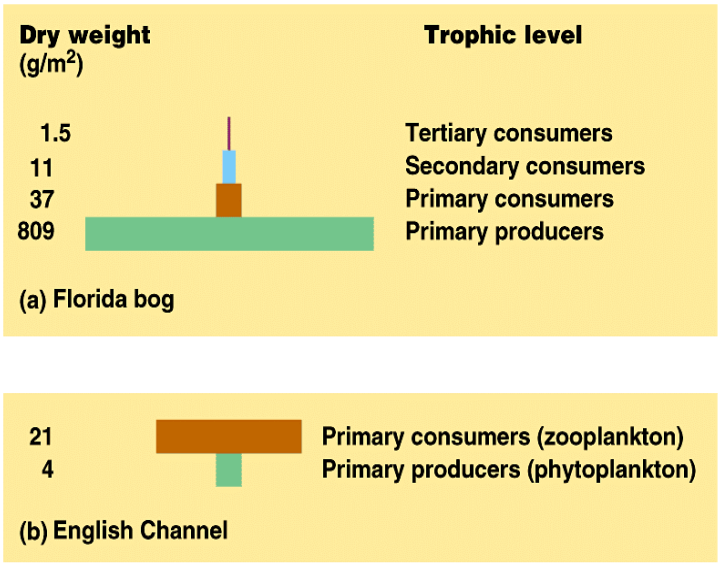


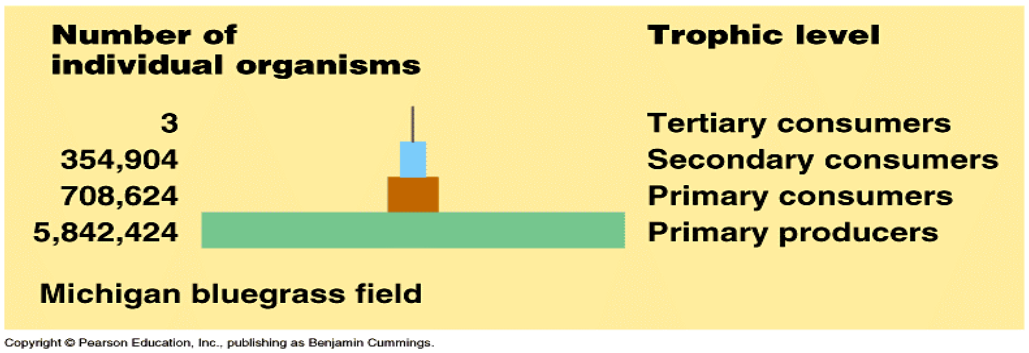


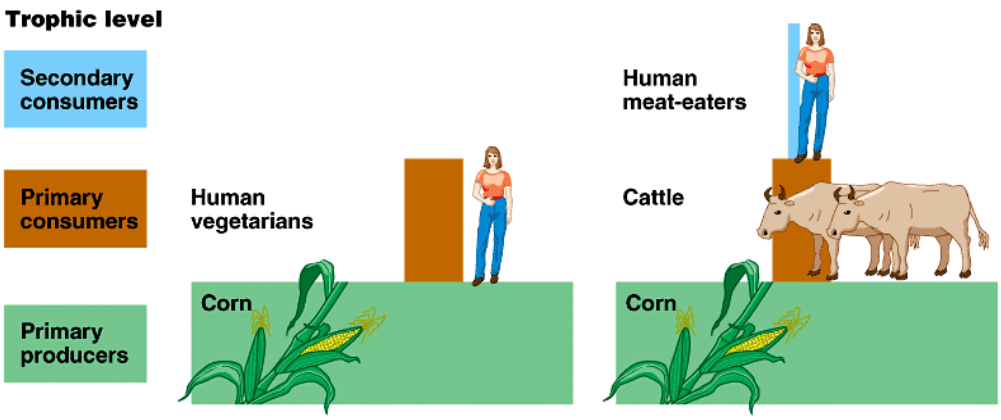


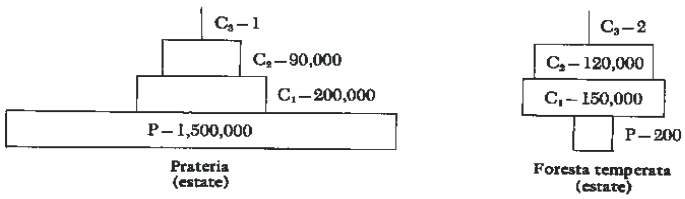
Magnificazione biologica



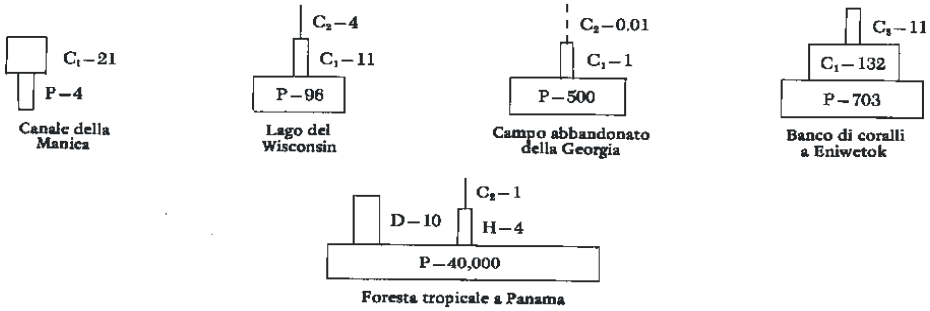




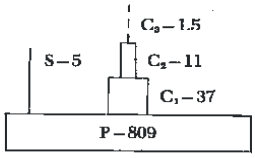




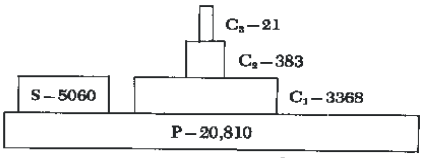
B. PIRAMIDI DI BIOMASSA. Grammi di peso secco per m^2



C. CONFRONTO TRA PIRAMIDI DI BIOMASSA E DI FLUSSO ENERGETICO A SILVER SPRINGS, FLORIDA

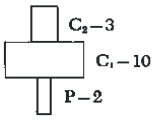


Biomassa: kcal/m²

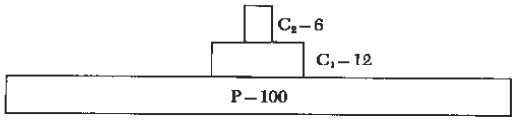


Flusso energetico: kcal/m²/anno

D. VARIAZIONI STAGIONALI DELLE PIRAMIDI DI BIOMASSA NELLA COLONNA D'ACQUA DI UN LAGO ITALIANO (SOLO PLANCTON DA RETINO). Milligrammi di peso secco per m³

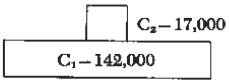


Inverno

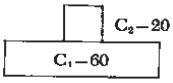


Primavera

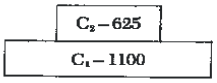
E. "SUBPIRAMIDI" DI NUMERI, DI BIOMASSA E DI ENERGIA RESPIRATORIA PER GLI ARTROPODI DEL SUOLO IN UN CAMPO ABBANDONATO DEL MICHIGAN



Individui/m²



Milligrammi/m²



Cal/m²/anno