I know an old lady who swallowed a cow
I don't know how she swallowed the cow
She swallowed the cow to catch the goat
She swallowed the goat to catch the dog
She swallowed the dog to catch the cat
She swallowed the cat to catch the bird
She swallowed the bird to catch the spider
That wriggled and jiggled and tickled inside her
She swallowed the spider to catch the fly
But I don't know why she swallowed that fly
Perhaps she'll die

Today's Objectives

Food chain

Trophic Level

Food Web

Ecosystem

"Steady-state" and ~~"Cyclicity"~~

Mass or Energy Flow (flux)

Trivia

Average Basal Energy Expenditure (BEE)/Basal **Metabolic Rate** (BMR) Among Men and Women. By lindsay wilson. The **average** basal energy expenditure (BEE), also known as basal **metabolic rate** (BMR), for American women is about 1,400 kilo-calories while for a man its roughly 1,800 kilo-calories.

One glazed Dunkin Donuts donut is 260 kilo-calories!

Why do you need to know about food chains, food webs, and trophic levels?

Why do you need to know about food chains, food webs, and trophic levels?

Energy

Nutrients

From WWF:
“Every plant and animal species, no matter how big or small, depends to some extent on another plant or animal species for its survival. “ …

“A food chain shows how energy is transferred from one living organism to another via food.” …

“A food chain describes how energy and nutrients move through an ecosystem. At the basic level there are plants that produce the energy, then it moves up to higher-level organisms like herbivores. After that when carnivores eat the herbivores, energy is transferred from one to the other.” …

What is a food chain?

Each of you, take a couple of minutes and create a sequence of organisms in a terrestrial food chain. (You should have at least four organisms; more than eight is too many for this exercise)

What is a food chain?

Take a couple of minutes and make a list of organisms in a terrestrial food chain.

Write yours down on the white board, put your primary producer if you have one at the bottom of the board.

Erin Conner Madeline Miles Joey

When all are up take a photo of this for Rob

Discussion Point

What was the basis for your food chain?

Once around the room.

Discussion Point

What was the basis for your food chain?

Once around the room.

Highlight the observational data that led to your chain.

- field experiments
- laboratory experiments

Tropic Levels – Examples from the whiteboard: PP, PC, SC, TC, AP,and D

PP primary producer/autotrophs—organisms, like plants, that produce food.
Examples:

PC primary consumer/heterotroph—an animal that eats primary producers.
Examples:

SC secondary consumer/heterotroph—an animal that eats primary consumers.
Examples:

TC tertiary consumer/heterotroph—an animal that eats secondary consumers.
Examples:

AP apex predator/heterotroph—an animal at the top of the food chain with no predators. Examples:

D decomposer/detritivores—organisms that break down dead plant and animal material
Examples:

Trophic Levels

primary producer/autotrophs—organisms, like plants, that produce food. Examples:

primary consumer/heterotroph—an animal that eats primary producers. Examples:

secondary consumer/heterotroph—an animal that eats primary consumers. Examples:

tertiary consumer/heterotroph—an animal that eats secondary consumers. Examples:

apex predator/heterotroph—an animal at the top of the food chain with no predators. Examples:

decomposer/detritivores—organisms that break down dead plant and animal material Examples:

Can a consumer occupy more than one trophic level?

Can a producer occupy more than one trophic level?

Trophic Levels

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decomposer/detritivores—organisms that break down dead plant and animal material Examples:

Can a consumer occupy more than one trophic level? Yes, example stripped bass

Can a producer occupy more than one trophic level?

Trophic Levels

primary producer/autotrophs—organisms, like plants, that produce food. Examples:

primary consumer/heterotroph—an animal that eats primary producers. Examples:

secondary consumer/heterotroph—an animal that eats primary consumers. Examples:

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apex predator/heterotroph—an animal at the top of the food chain with no predators. Examples:

decomposer/detritivores—organisms that break down dead plant and animal material Examples:

Can a consumer occupy more than one trophic level? Yes, example rat

Can a producer occupy more than one trophic level? Yes, example venus flytrap

What is a food web?

What is a food chain?

Take a couple of minutes and make a list of organisms in a terrestrial food chain.

Write yours down on the white board

Erin Conner Madeline Miles Joey

Using the white board –

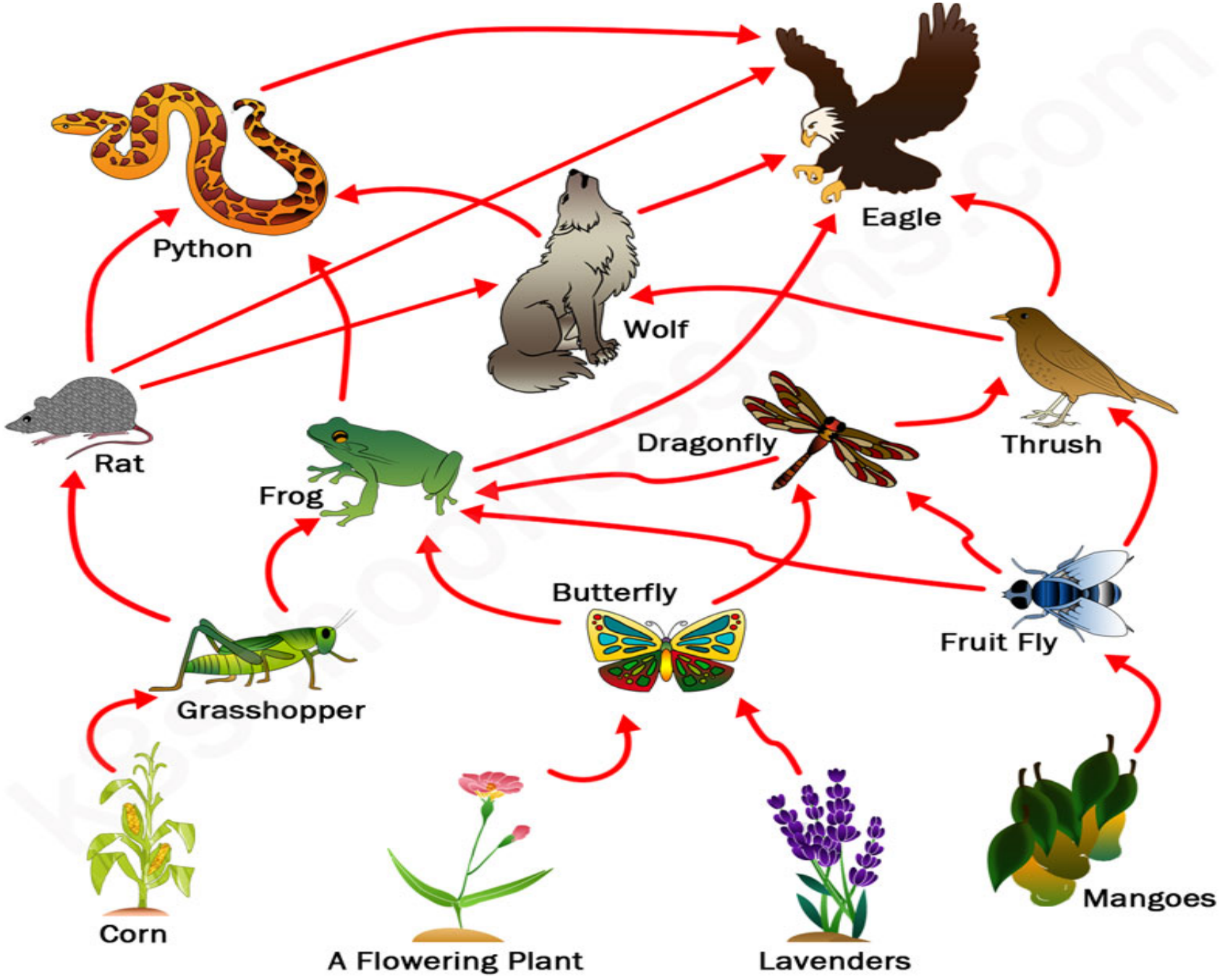
1. Erin please draw arrows going from your PP to all of the PCs
Then draw arrows from the other PPs to your PC

2. Madeline, when Erin is done, draw arrows from your SC to all of the consumers which could eat it. Then draw arrows to you SC from the other organisms it eats.

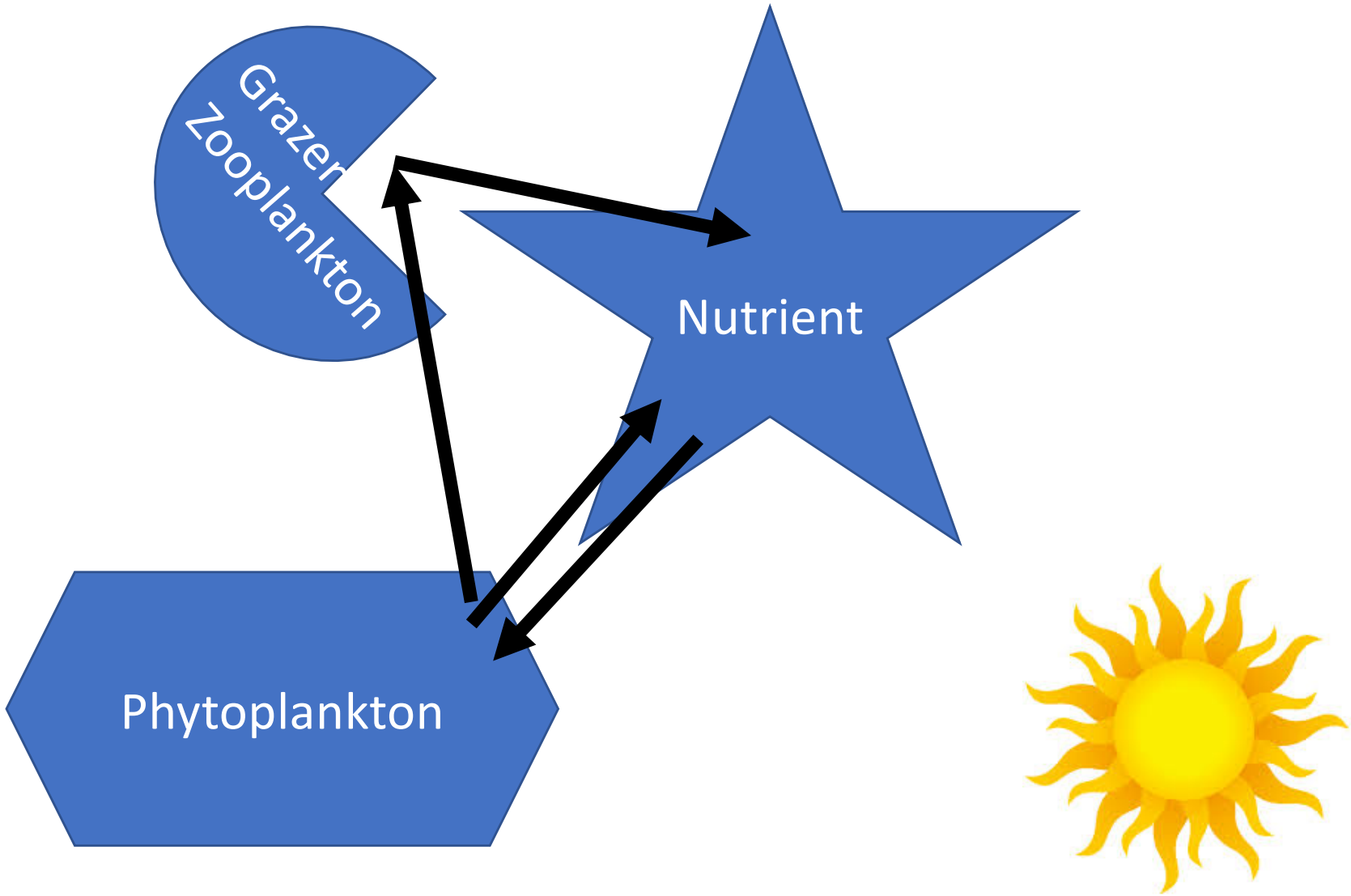
3. Joey, when Madeline is done, draw arrows to your AP from all of the other organism it eats.

When all are done take a photo of this for Rob

Food Chain to Food Web: Cartoon Example



Highly reduced and stylized marine food web:
Three aggregated components and “currency” could be energy, or carbon mass, or nutrient mass (nitrogen, iron, phosphorous, …)



“Currency Rules” for The Stylized NPZ

Nutrient, Phytoplankton and Zooplankton pools.

Nutrient – acquired from plankton, phyto and zoo.
lost to phytoplankton.

Phytoplankton – acquired from nutrient.
lost to nutrient and zooplankton.

Zooplankton – acquired from phytoplankton
lost to nutrient.

Total is constant such the sum of Zooplankton, Phytoplankton and Nutrient adds up to the Total

$$T = Z + P + N$$

Nutrient – source from plankton, phyto and zoo.
sink to phytoplankton.

$N_{source} = R_{pn} + R_{zn}$
$= K_{pn}[P] + K_{zn}[Z]$

$N_{sink} = - R_{np}$
$= -K_{np}[N][P]$

Time rate of change of N equals source - sink

$$\frac{d[N]}{dt} = K_{pn}[P] + K_{zn}[Z] - K_{np}[N][P]$$

At “Steady-state” the time rate of change of N is zero or

$$K_{pn}[P] + K_{zn}[Z] - K_{np}[N][P] = 0$$

Phytoplankton – source from nutrients.
sink to zooplankton.

$P_{sink} = -R_{pz}$
$= -K_{pz}[P][Z]$

$P_{source} = +R_{np}$
$= K_{np}[N][P]$

Time rate of change of P equals source - sink

$$\frac{d[P]}{dt} = K_{np}[N][P] - K_{pz}[P][Z]$$

At “Steady-state” the time rate of change of P is zero or

$$K_{np}[N] - K_{pz}[Z] = 0$$

Zooplankton – source from phytoplankton.
sink to nutrients.

$Z_{source} = R_{pz}$
$= K_{pz}[P][Z]$

$Z_{source} = - R_{zn}$
$= -K_{zn}[Z]$

Time rate of change of Z equals source - sink

$$\frac{d[Z]}{dt} = K_{pz}[P][Z] - K_{zn}[Z]$$

At “Steady-state” the time rate of change of P is zero or

$$K_{pz}[P] - K_{zn} = 0$$

NPZ Trophic Steady-State Summary

$$K_{pz}[P] - K_{zn} = 0$$

$$K_{np}[N] - K_{pz}[Z] = 0$$

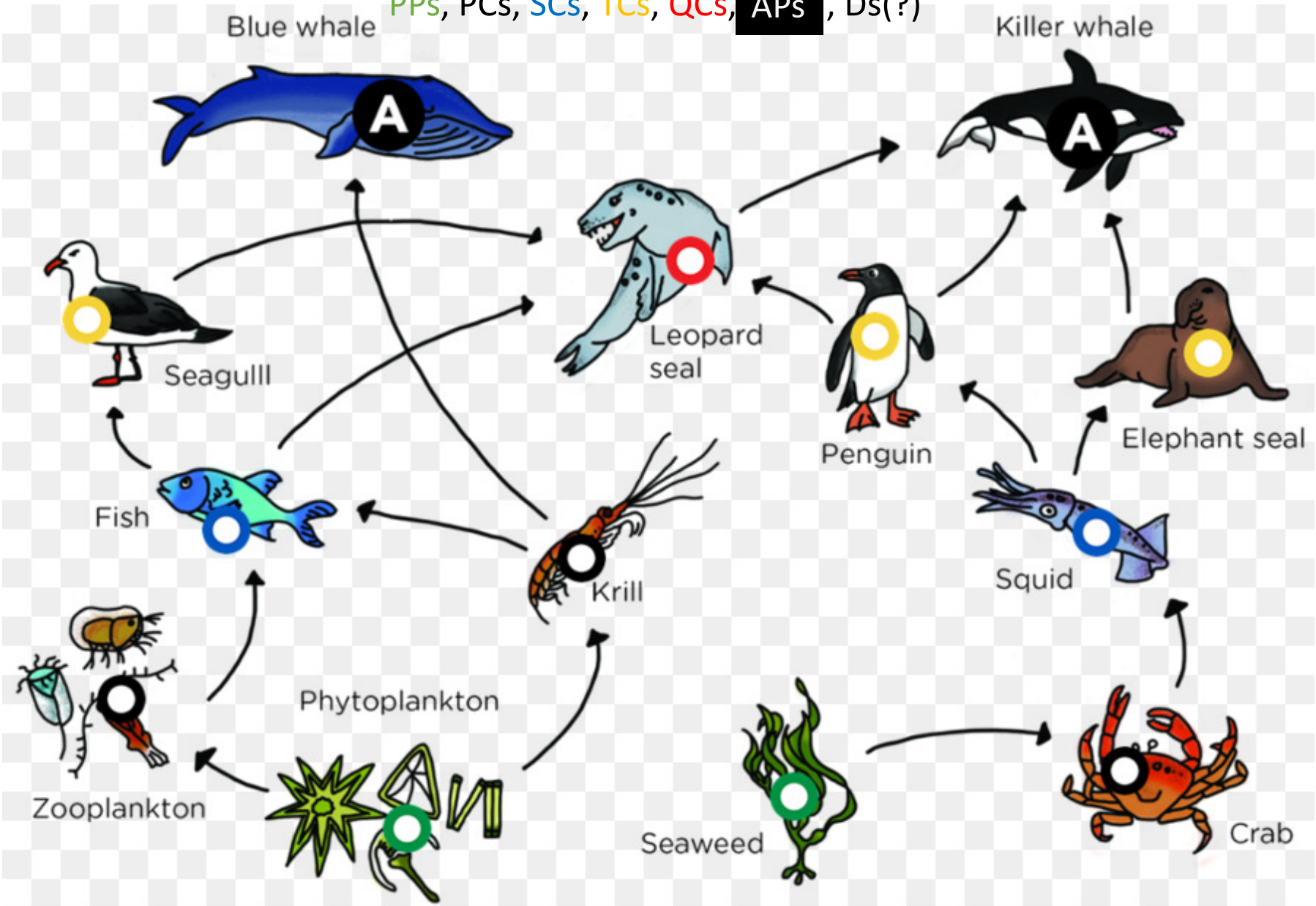
$$K_{pn}[P] + K_{zn}[Z] - K_{np}[N][P] = 0$$

$$[T] = [Z] + [P] + [N]$$

Algebraically solve for N, P and Z in terms of [T] and the interaction coefficients, K. Turn your answers in to me Tuesday, September 18, at the start of class.

Arctic Marine Food Web – Cartoon Example II

PPs, PCs, SCs, TCs, QCs, **APs**, Ds(?)

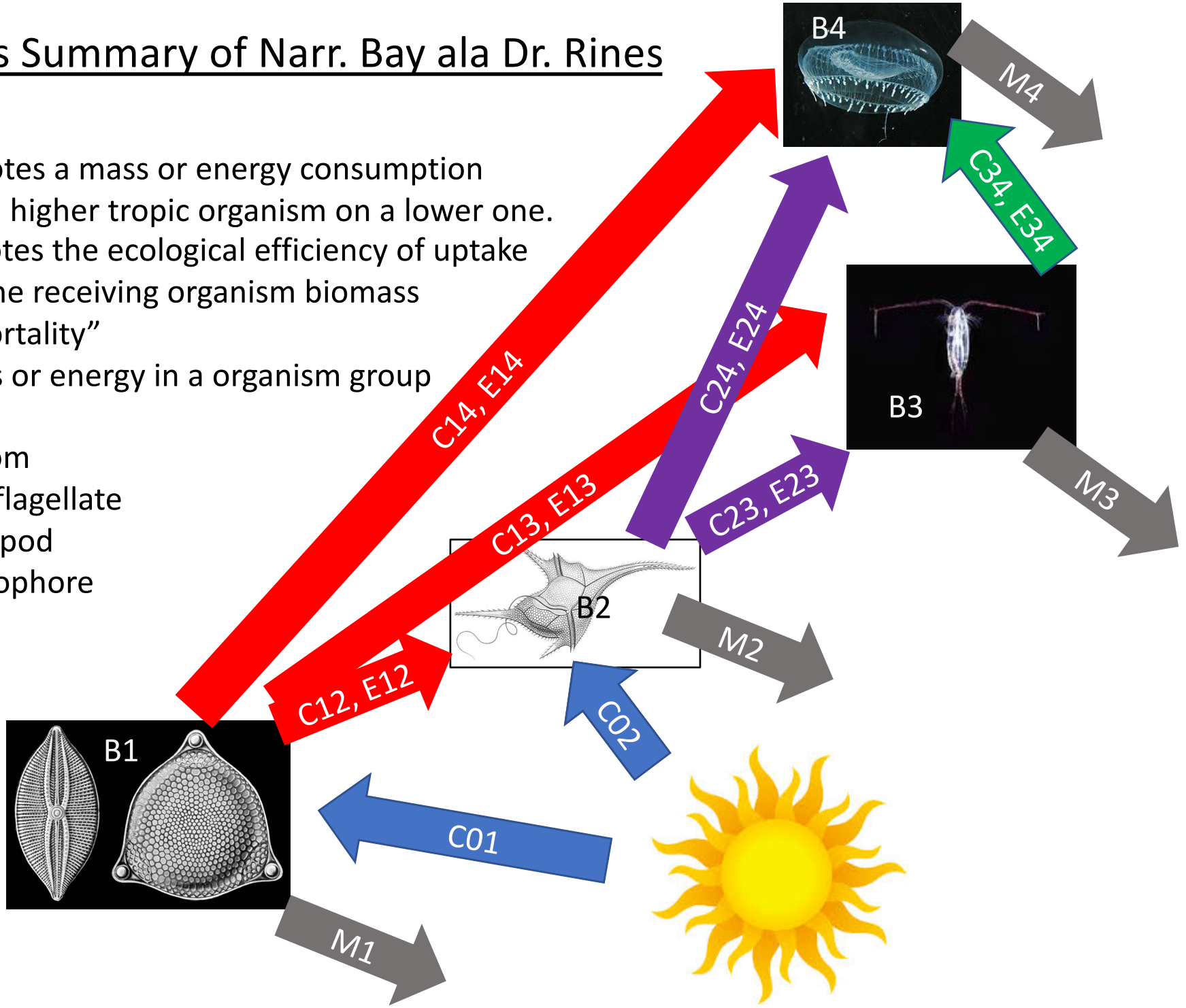


https://www.kisspng.com/png-arctic-ocean-food-web-food-chain-1830291/

Brian's Summary of Narr. Bay ala Dr. Rines

C – denotes a mass or energy consumption
by a higher tropic organism on a lower one.
E – denotes the ecological efficiency of uptake
by the receiving organism biomass
M – "mortality"
B – mass or energy in a organism group

1 – diatom
2 – dinoflagellate
3 – copepod
4 – ctenophore

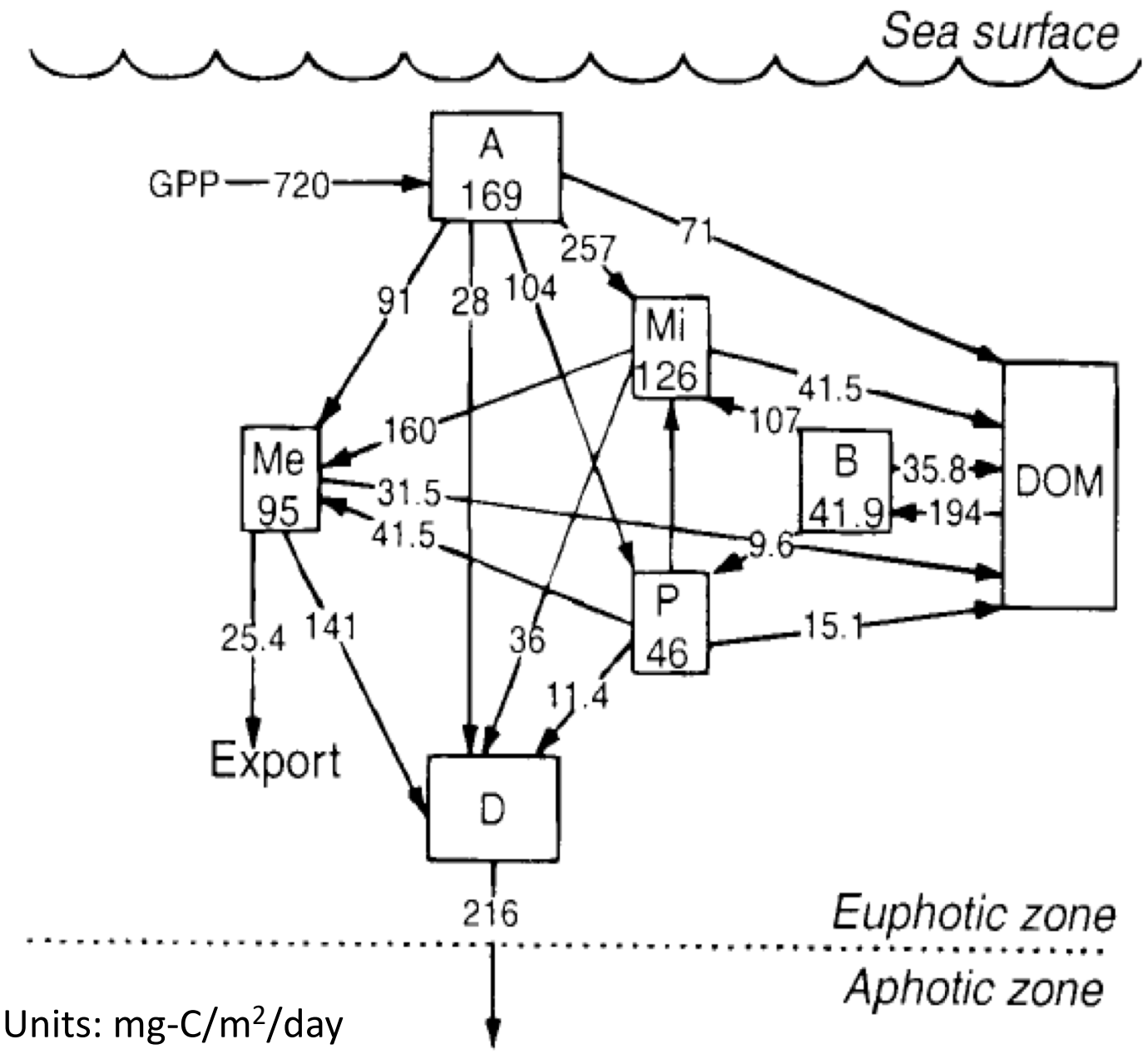


Read Steele [2001] for Tuesday's Class
On Sakai

Network analysis of food web models.

Linear mass or energy "flow" analysis at "steady-state".

Carbon fluxes in summer at a station in the English Channel



A – autotroph (photsynth.)
B - Bacteria
P - Protist
Mi - Microzoo.
Me - Mesozoo.
D – Detritus
DOM – dissolved organic matter

GPP – gross primary production

Export – export production to higher organisms

Numbers on arrow - carbon flux into a ”box”.

Numbers in a box - respiration

Additional Vocabulary

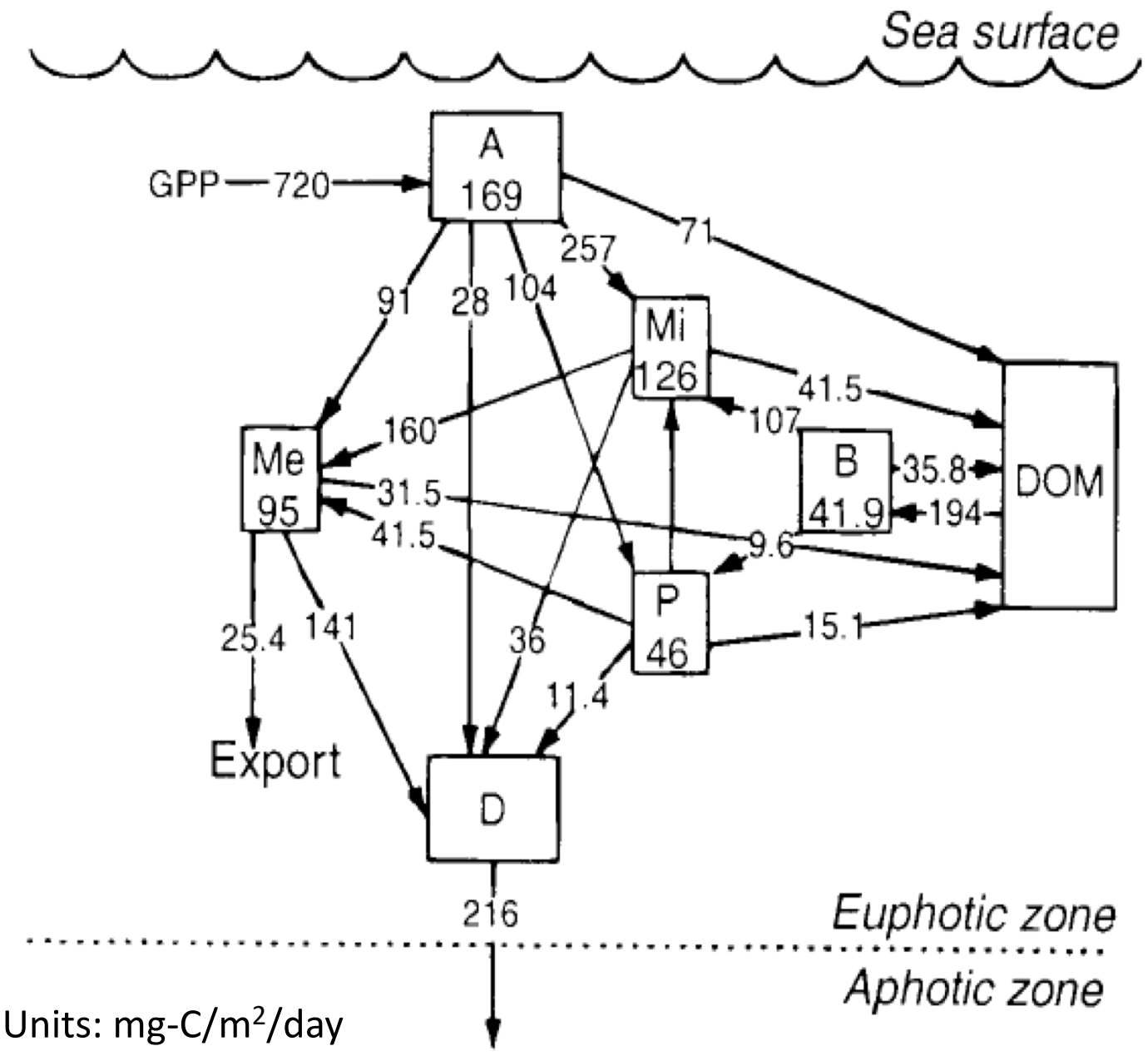
- Invasive species
  - Ex 1 – lion fish (occasionally present in NB)
  - Ex 2 – European green crab
  - Ex 3 – snakehead
  - Ex 4 –

- Think about how such an organism could disrupt an ecosystem, food web, food chain, …

- If changes in climate effect the Bay, what are some of the possible disruptions?

- Learn more
  - http://www.crmc.ri.gov/invasives.html
  - https://nas.er.usgs.gov/

Carbon fluxes in summer at a station in the English Channel



A – autotroph (photosynthetic org.)
B - Bacteria
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