Answers to exercises of Chapter 12 (Ecological Networks)

1.
The graphical representation of the binary food web is depicted in Fig. 1. S=4, L=5, D=5/4 and $C=L/S^2$ = 5/16 (directed connectance). Species 1 and 2 are basal species and species 4 is the top predator.

2.
a) The quantitative trophic food web in units of mg C m^{-2} d^{-1} is presented in Fig. 2. The thick arrows pointing downwards represent respiration and the horizontal arrows egestion. Since non-grazing mortality is ignored, production at the lower trophic level equals ingestion at the higher trophic level. The omnivores ingest 25 mg C m^{-2} d^{-1} produced by herbivores.
b) The food web model in units of mg P m^{-2} d^{-1} based on a carbon to phosphorus ratio of 100:1 for the primary producers and 40:1 for the animals is depicted in Fig. 3. The omnivores ingest 0.25 + 0.625 = 0.875 mg P m^{-2} d^{-1}. The herbivores release 0.75-0.625 = 0.125 mg P m^{-2} d^{-1} and the omnivores 0.875 – 0.415 = 0.46 mg P m^{-2} d^{-1}.
c) Assuming a ratio between carbon and phosphorus of 200:1 for the primary producers and of 40:1 for the animals results in a phosphorus limitation of the herbivores. They ingest 75 mg C m^{-2} d^{-1} which contain 0.375 mg P m^{-2} d^{-1}. Having a carbon to phosphorus ratio of 40:1 herbivores may convert these 0.375 mg P m^{-2} d^{-1} ingested into 0.375*40=15 mg C m^{-2} d^{-1} production which is lower than what would be possible based on energetic constrains (i.e. 25 mg C m^{-2} d^{-1}, cf. Fig. 2). That is, the 75 mg C m^{-2} d^{-1} taken up by the herbivores cannot be converted into new biomass production efficiently due to phosphorus shortage. The carbon taken up in excess is respired and/or egested. This implies that the omnivore has a lower carbon and phosphorus supply via the herbivores if the primary producers are strongly nutrient depleted.

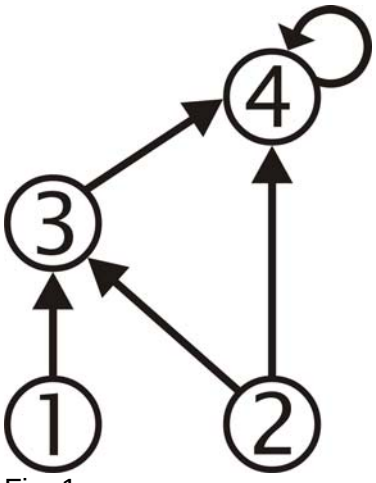
4
3
1
2

Fig. 1

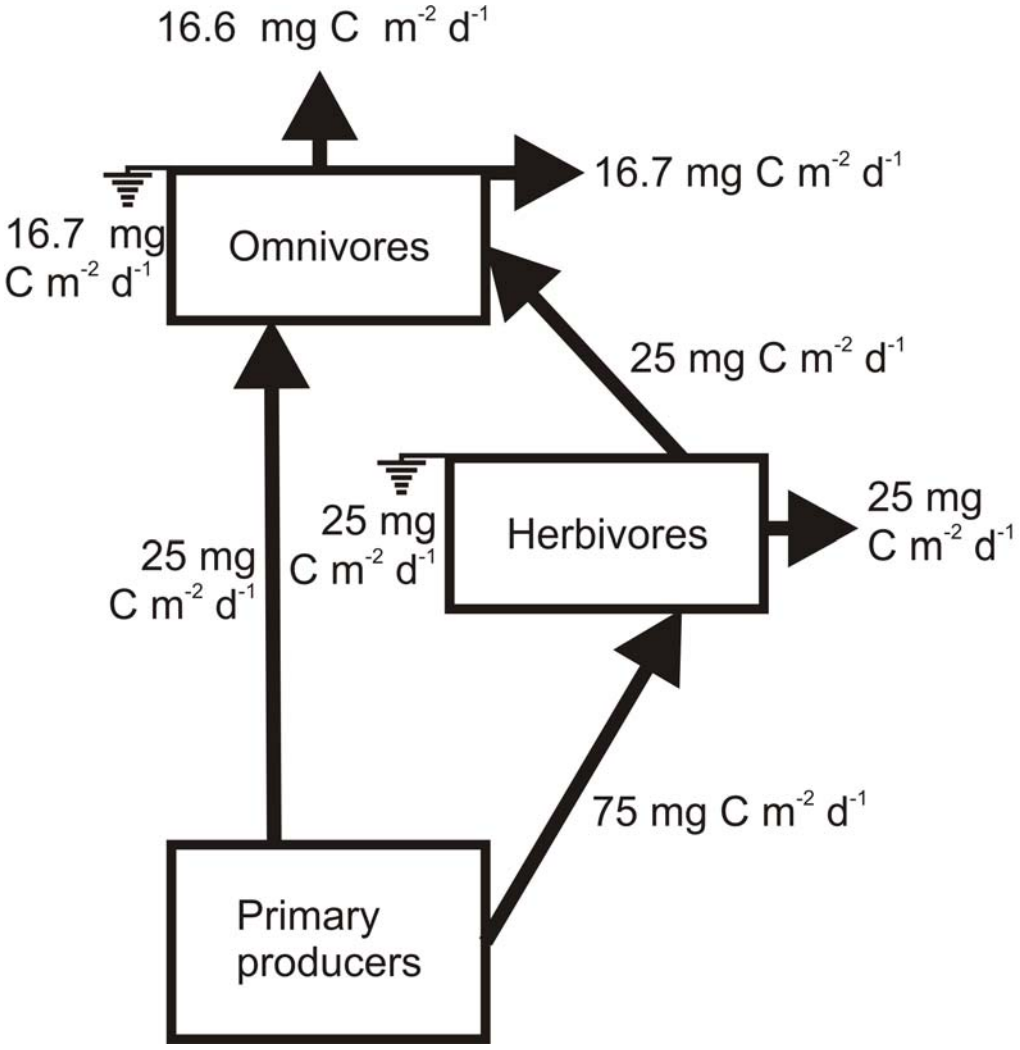
16.6 mg C m-2 d-1
16.7 mg C m-2 d-1
16.7 mg C m-2 d-1
Omnivores
25 mg C m-2 d-1
25 mg C m-2 d-1
Herbivores
25 mg C m-2 d-1
25 mg C m-2 d-1
75 mg C m-2 d-1
Primary producers

Fig. 2

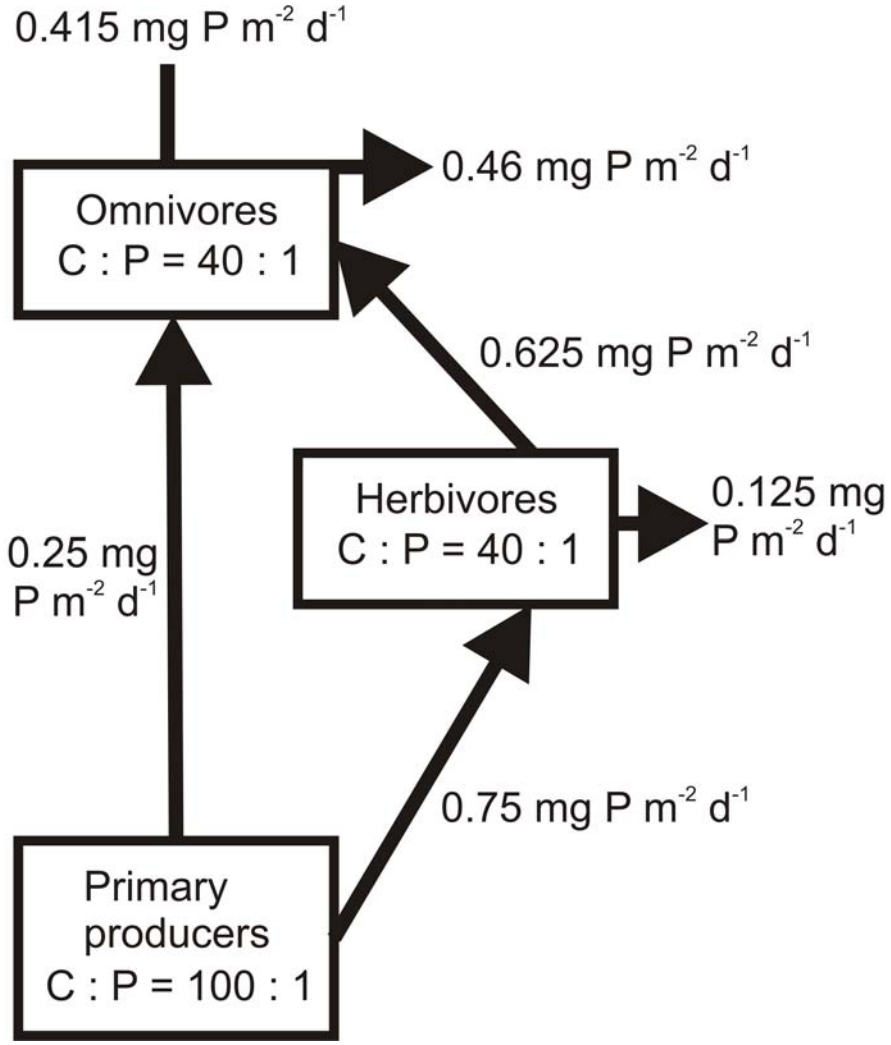
0.415 mg P m-2 d-1
0.46 mg P m-2 d-1
Omnivores
C : P = 40 : 1
0.625 mg P m-2 d-1
Herbivores
C : P = 40 : 1
0.125 mg
P m-2 d-1
0.25 mg
P m-2 d-1
0.75 mg P m-2 d-1
Primary
producers
C : P = 100 : 1

Fig. 3