Overfishing of planktivorous fishes and eutrophication may have the same impact on the structure of marine planktonic food webs

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Background

It is generally assumed that the predator-prey relationship is antagonistic, and therefore that exploitation of planktivorous fish (PF) will result in increased abundance of their planktonic prey.

However, in a book published in 2014 (Ch. 6 and 7), it is suggested that overfishing of PF will result in the opposite situation, with reduced abundance of favourable prey for PF, which implies a synergistic predator-prey relationship. The relationship between zooplankton and their algal prey is also considered to be synergistic.

New book 2014
Elsevier

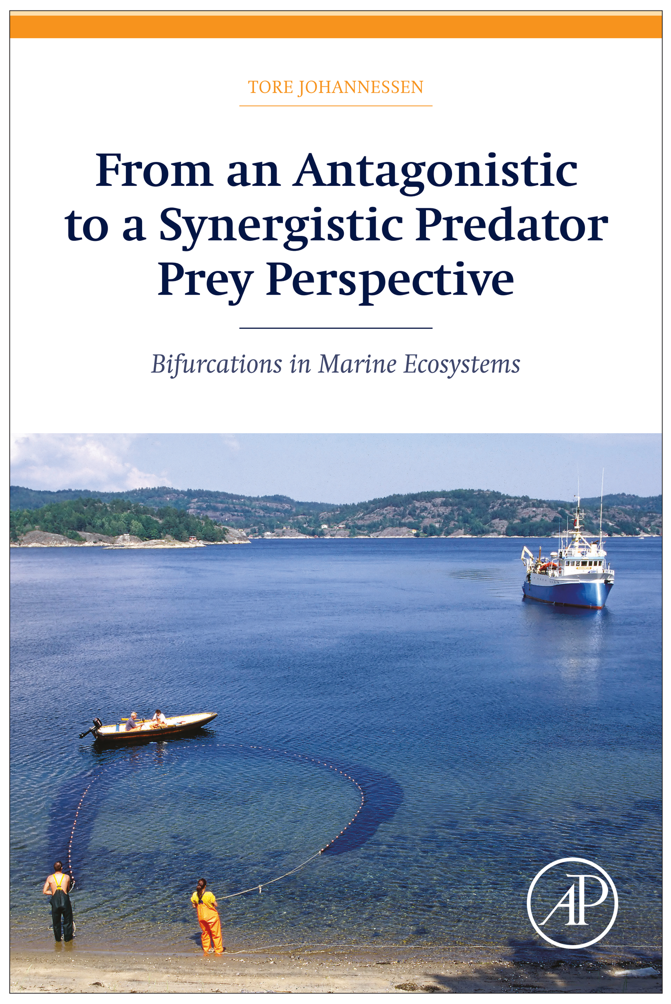
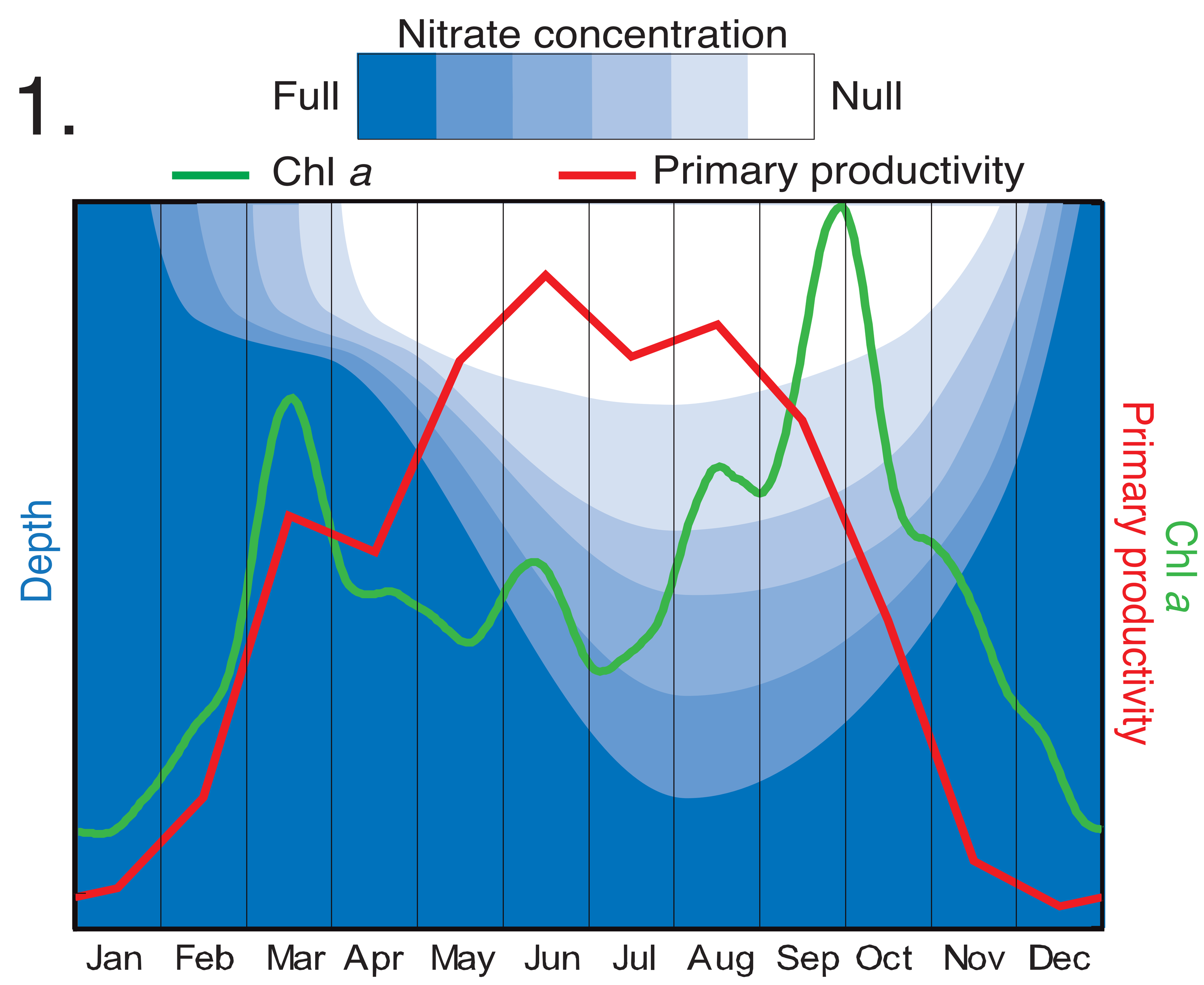


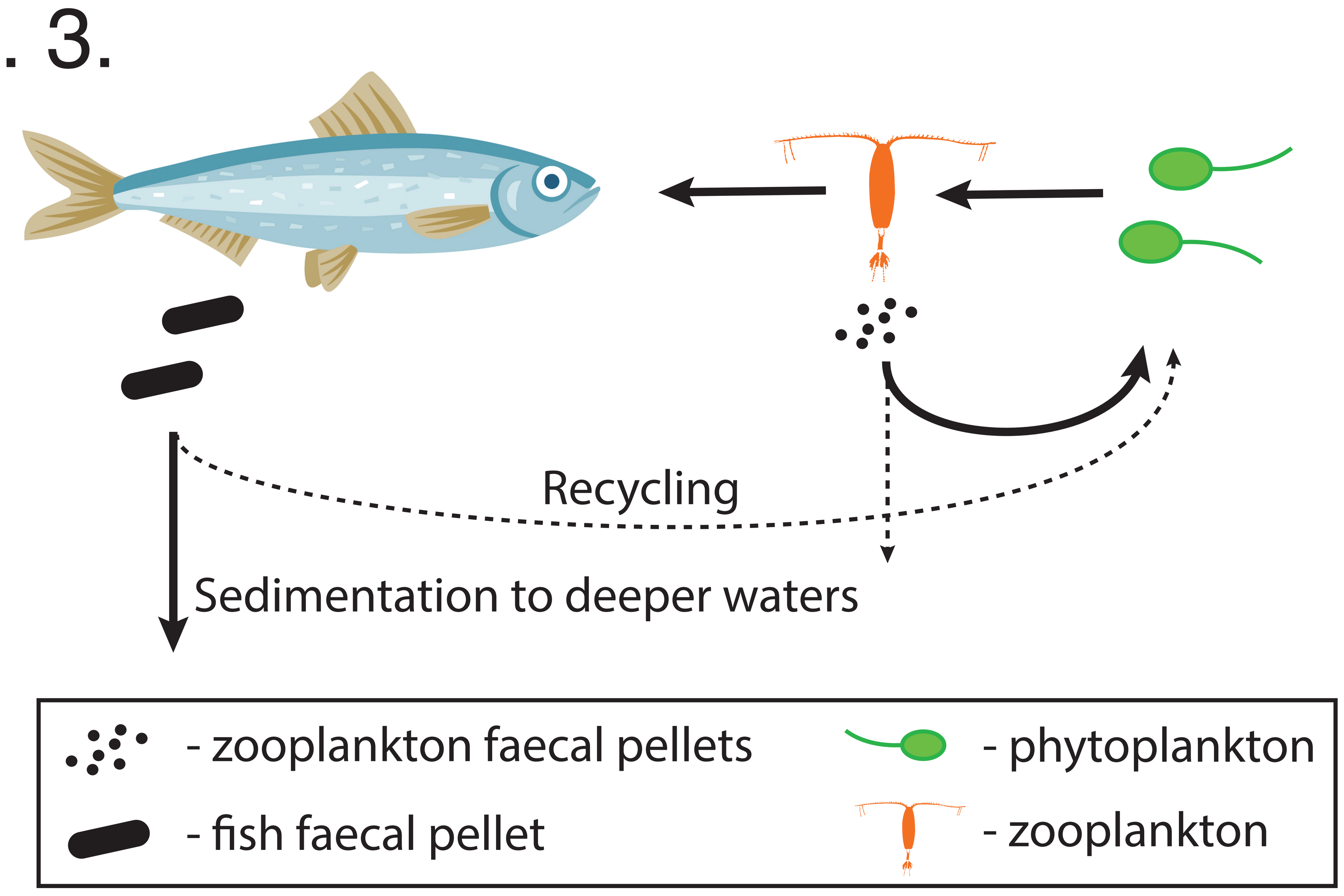
Fig. 1.



Measurements of Chl *a,* primary productivity (PP) and nutrients (nitrate) in Skagerrak coastal waters show that PP is maximum in summer when the algal biomass (Chl *a*) is low and nutrients in the euphotic layer hardly detectable when measured at macroscales. This implies high grazing rates, rapid cycling of ample nutrients at microscales and the dominance of edible phytoplankton (in contrast to the autumn bloom of inedible dinoflagellates).

The increase in PP from April to summer is a result of nutrients from deeper water being mixed into the euphotic layer, where they are captured and recycled.

Fig. 3.

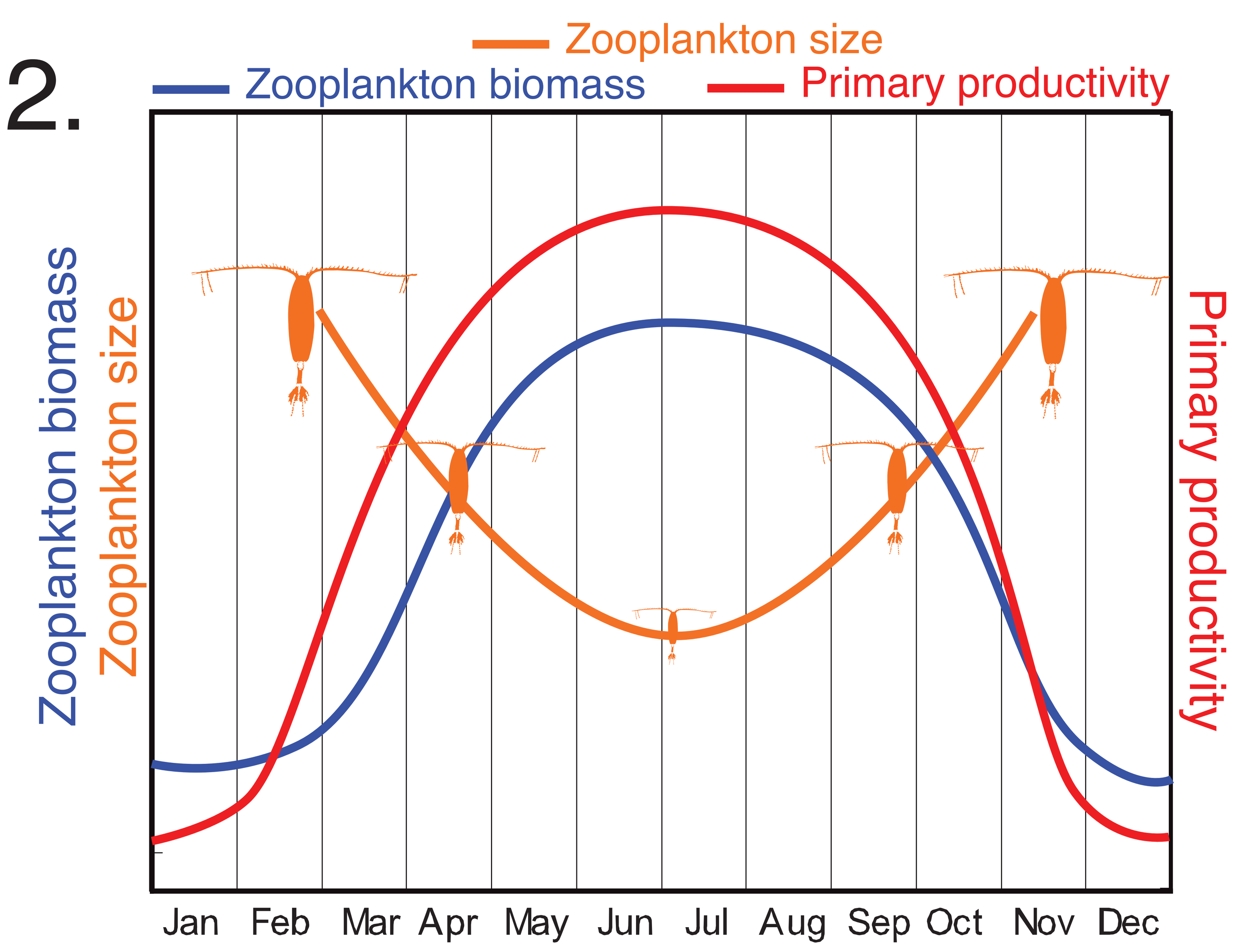


The faith of faecal pellets from zooplankton and planktivorous fish.

Mechanism and implications

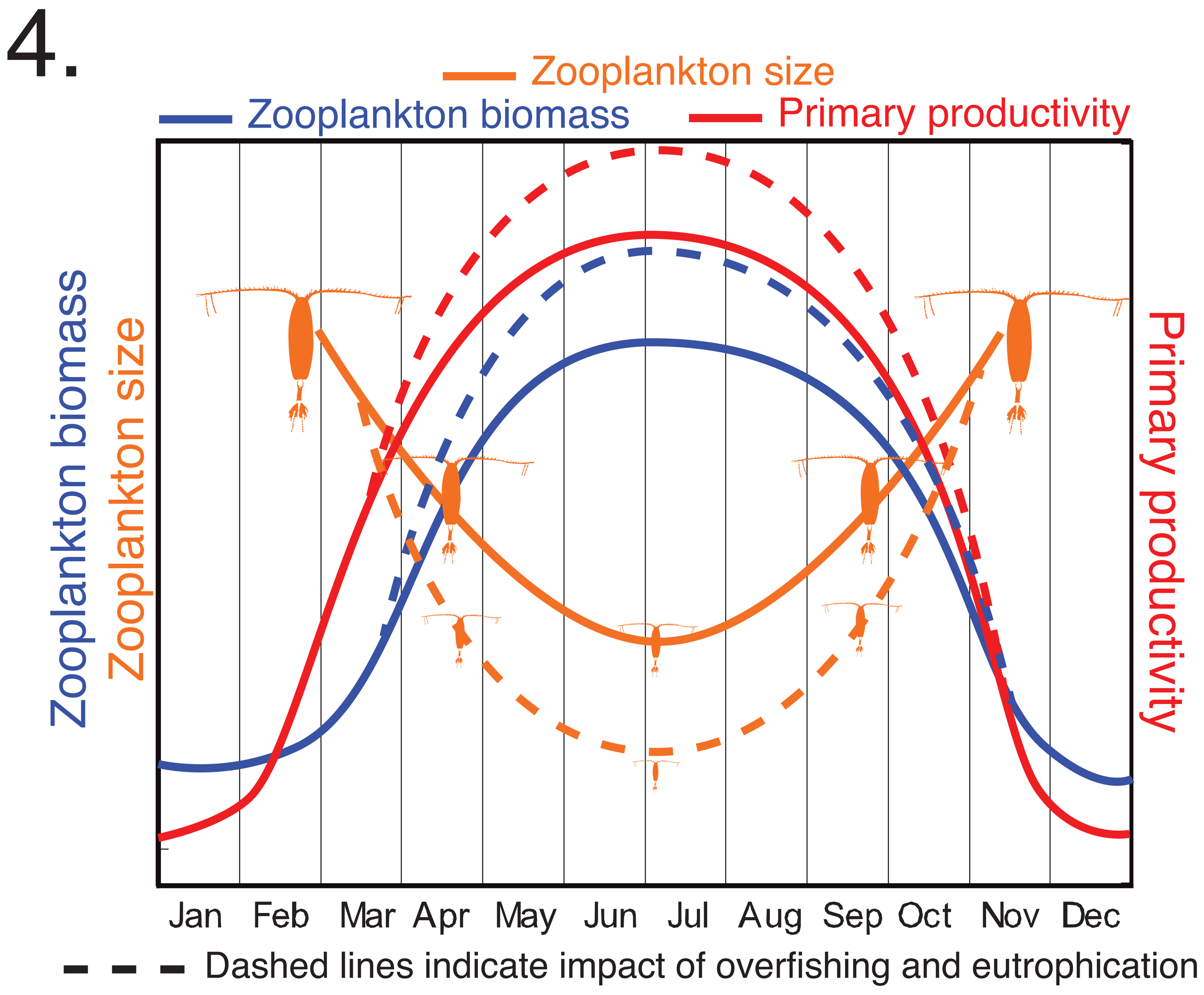
1. From April to summer primary productivity (PP) ~doubles (Fig. 1). As there is no corresponding increase in algal biomass, algal growth rates must also ~double. This causes a shift from large slow-growing to small fast-growing algae, and a corresponding reduction in the size of zooplankton (Fig. 2). Hence, low PP - large plankton, high PP - small plankton.
2. The biomass of zooplankton increases with increasing PP, but the size decreases (Fig. 2).
3. Small faecal pellets from zooplankton are recycled in the euphotic layer, whereas the larger faecal pellets from fish sink rapidly and cause loss of nutrients to deeper waters (Fig. 3).
4. Overfishing of planktivorous fish (PF) results in reduced export of nutrients from the euphotic layer, increased PP (Fig. 4), reduced size in zooplankton, longer food chains, and reduced energy flow to higher trophic levels, including lower food availability for PF as they generally feed on larger zooplankton.
5. Eutrophication also result in increased PP and reduced size in zooplankton (Fig 4).
6. Management of marine resources should therefore aim at maintaining large stocks of PF, and eutrophication should be avoided.

Fig. 2.



Principal outline of the relationship between primary productivity (PP) and zooplankton size and biomass during the seasonal succession (zooplankton size during winter is not indicated because many larger zooplankton diapause in deeper waters).

Fig. 4.



Principal outline of the impact on the plankton community of overfishing of planktivorous fish (PF) and eutrophication.