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Temporal changes in phytoplankton biomass and cellular properties; implications for the IMO Ballast Water Convention

Trindade de Castro, Maria Cecilia

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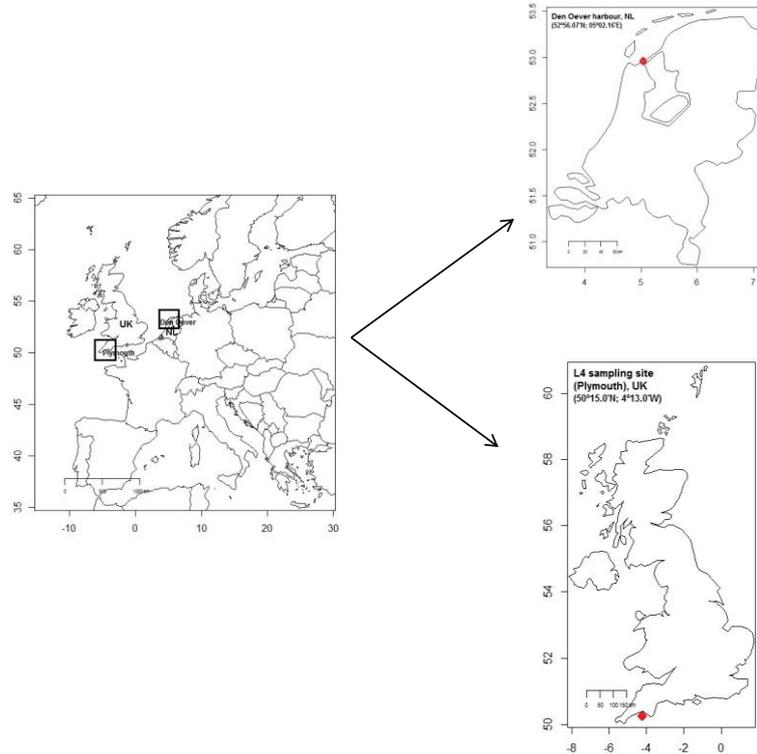


Fig. 1: Study area showing Den Oever harbour in the Wadden Sea, The Netherlands ($52^{\circ}56.07'N$; $05^{\circ}02.16'E$) and the L4 sampling site in the Western English Channel, UK ($50^{\circ}15.0'N$; $4^{\circ}13.0'W$).

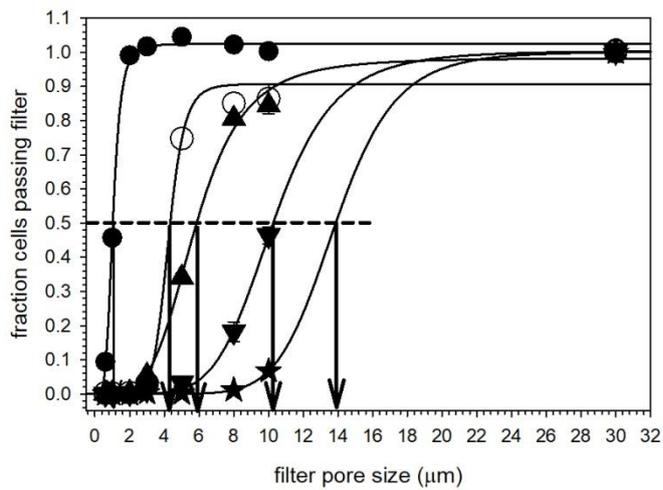


Fig. 2: fraction of initial cell number of 4 different phytoplankton species remaining present in filtrate as a function of applied filter pore size. Lines are calculated fit of logistic function. Arrows are associated cell size based on 50% of cells present.

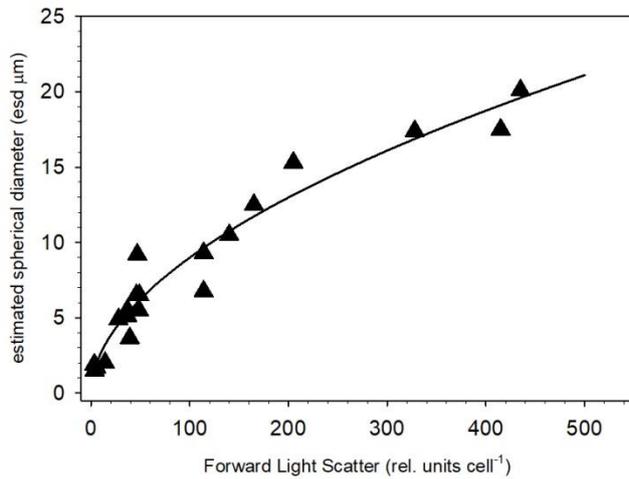


Fig. 3: forward light scatter versus size fractionated estimated spherical cell diameter

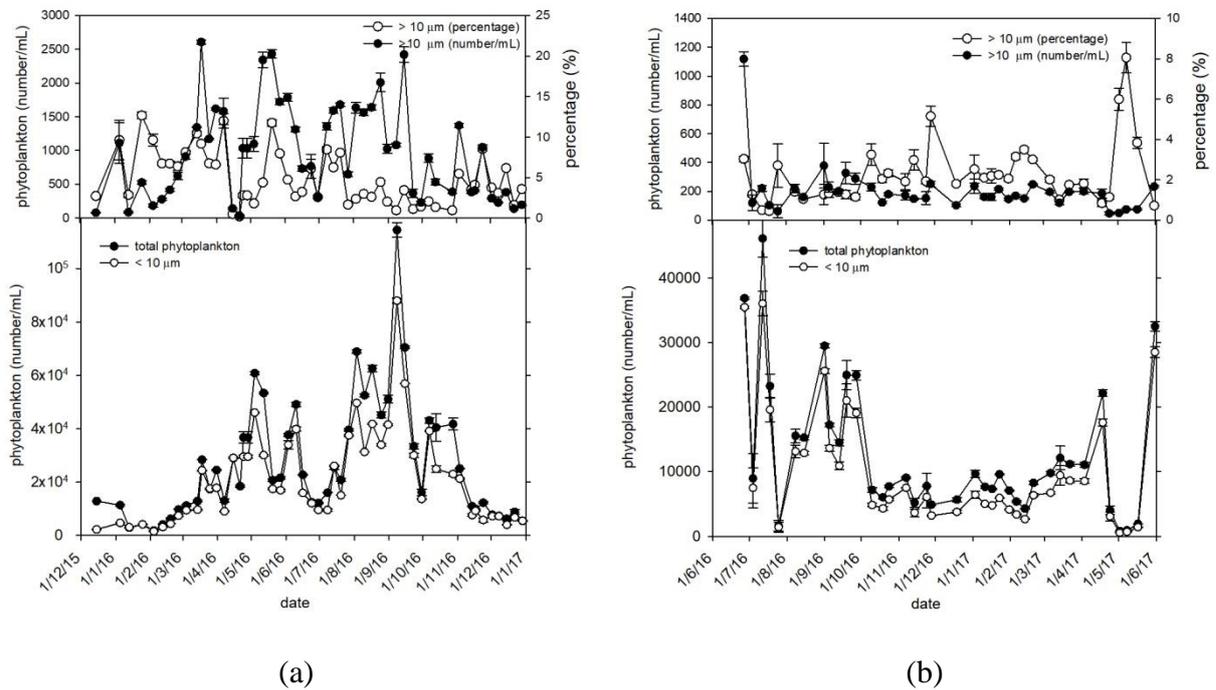
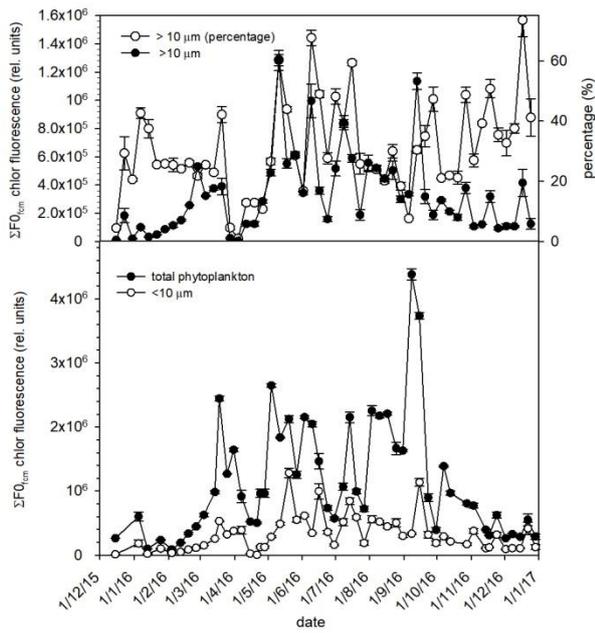
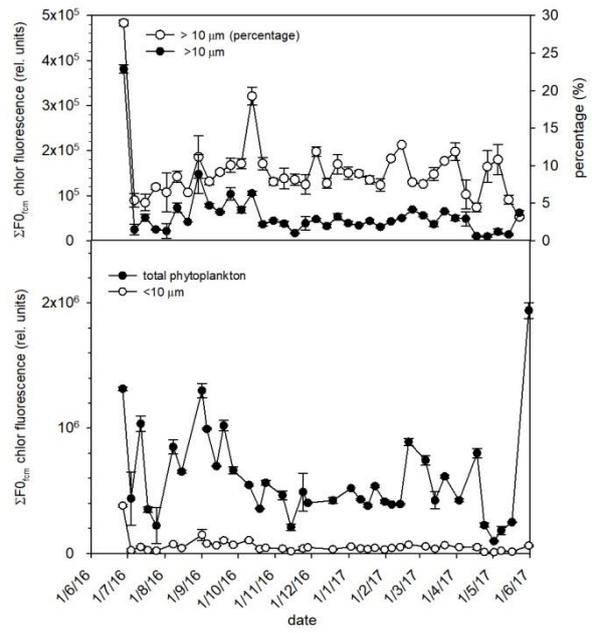


Fig. 4: annual number of total phytoplankton and fraction <10 micron (bottom graph). Number and percentage of phytoplankton cells in fraction >10 micron (top graph): Den Oever (a) and L4 (b).

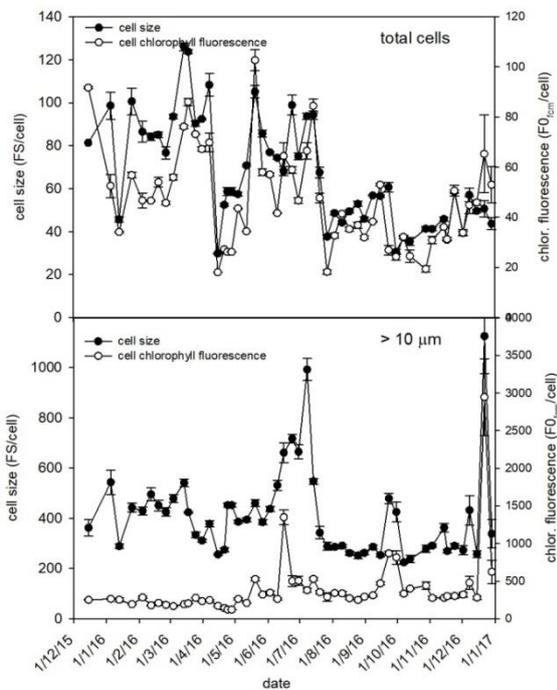


(a)

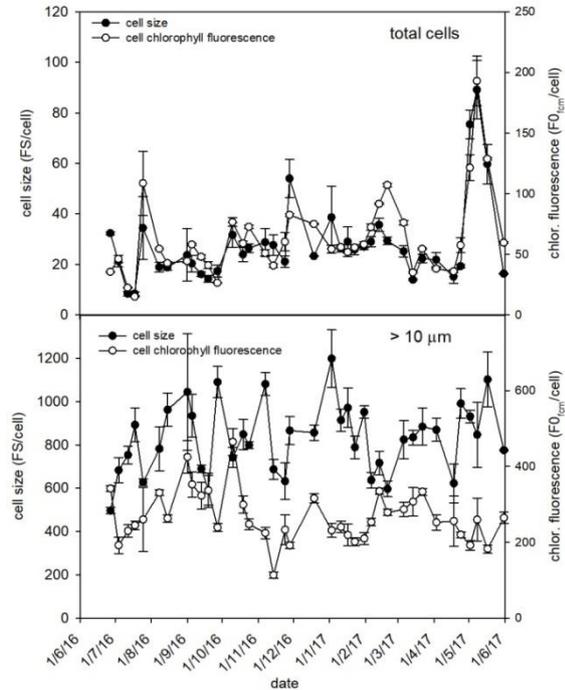


(b)

Fig. 5: annual flow cytometric integrated chlorophyll concentration of total phytoplankton and fraction $<10 \mu\text{m}$ (bottom graph). Integrated chlorophyll concentration and percentage of chlorophyll in fraction $>10 \mu\text{m}$ (top graph): Den Oever (a) and L4 (b).



(a)



(b)

Fig. 6: annual variation in cell size and cellular chlorophyll autofluorescence of total phytoplankton community (2 - > 50 micron) and size class > 10 micron: Den Oever (a) and L4 (b).

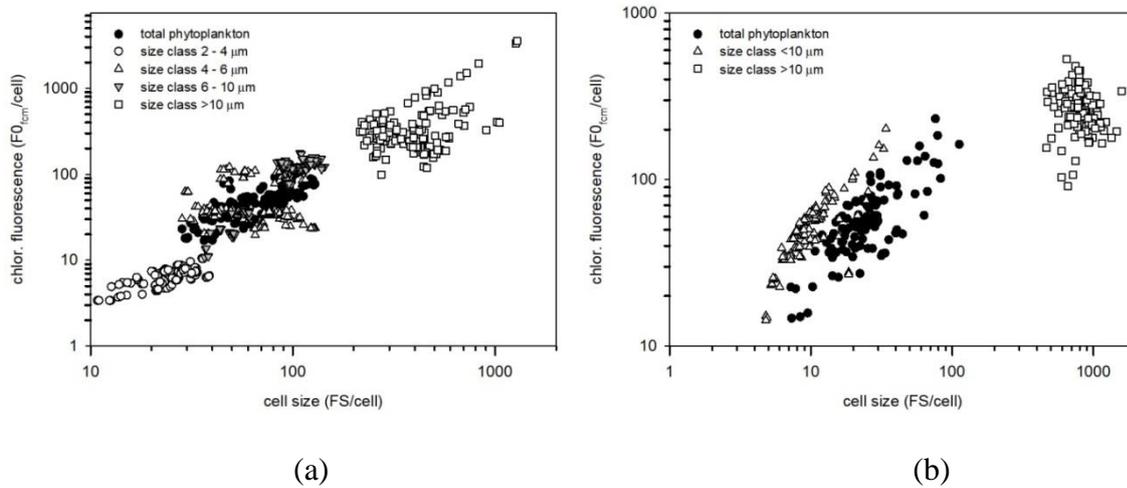
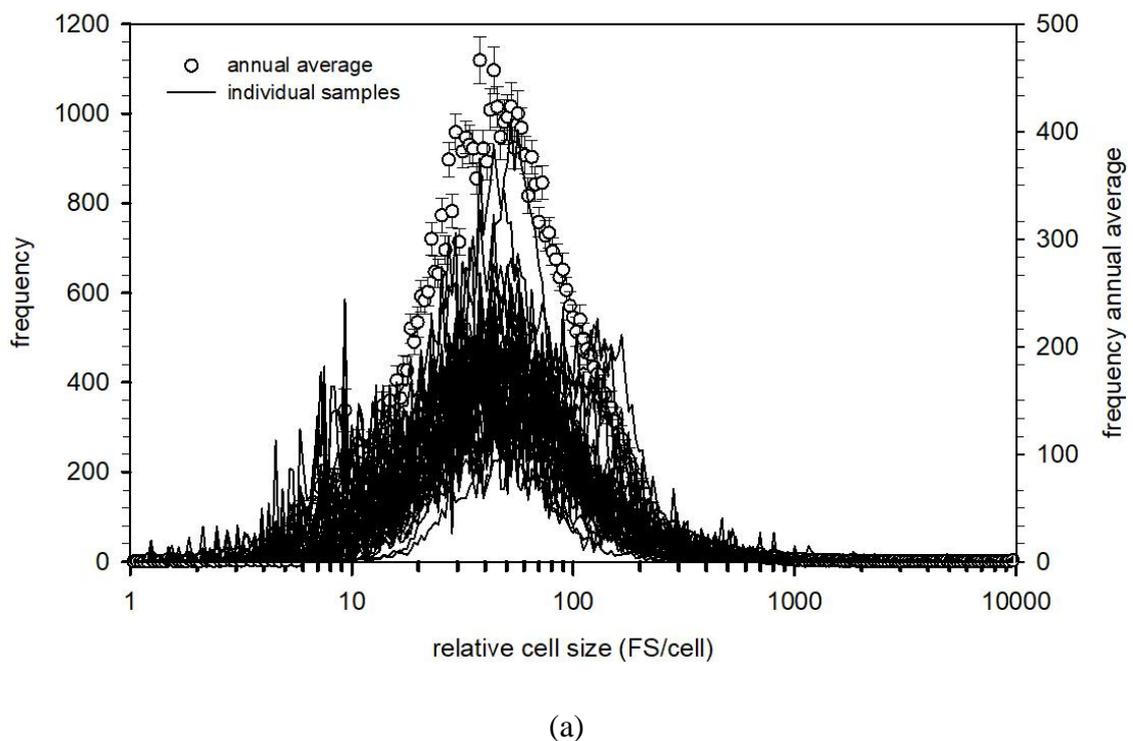
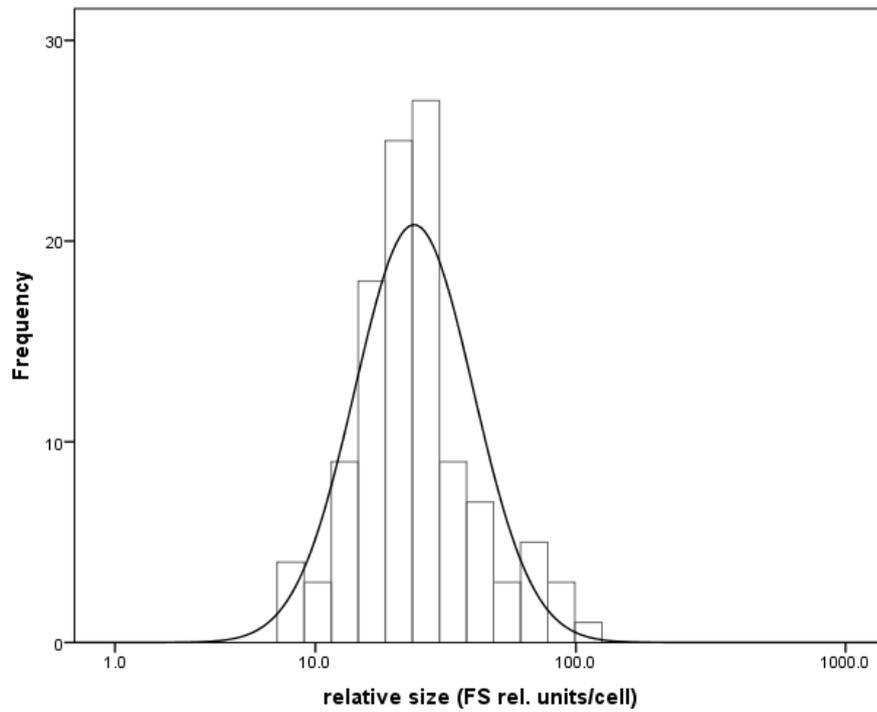


Fig. 7: Covariation between cell size (measured as forward light scatter) and cellular chlorophyll autofluorescence of total phytoplankton community (2 - 50 μm) and different subpopulations 2 – 4 μm , 4 to 7 μm , 7 to 10 μm and > 10 μm (Den Oever data - a). Same covariation for the total number of cells (2 to 50 μm) and for organisms between 2 and 10 and from 10 to 50 μm (L4 data - b).





(b)

Fig. 8: frequency distribution of cell size of each sampling day in Den Oever (average of 3 replicates, black lines) and annual average ± 1 sd (right scale) (a) and frequency distribution of cell size for total phytoplankton at station L4 considering all samples/replicates in the period (N=114, FS= 28.2 CV%= ± 63.2) (b).

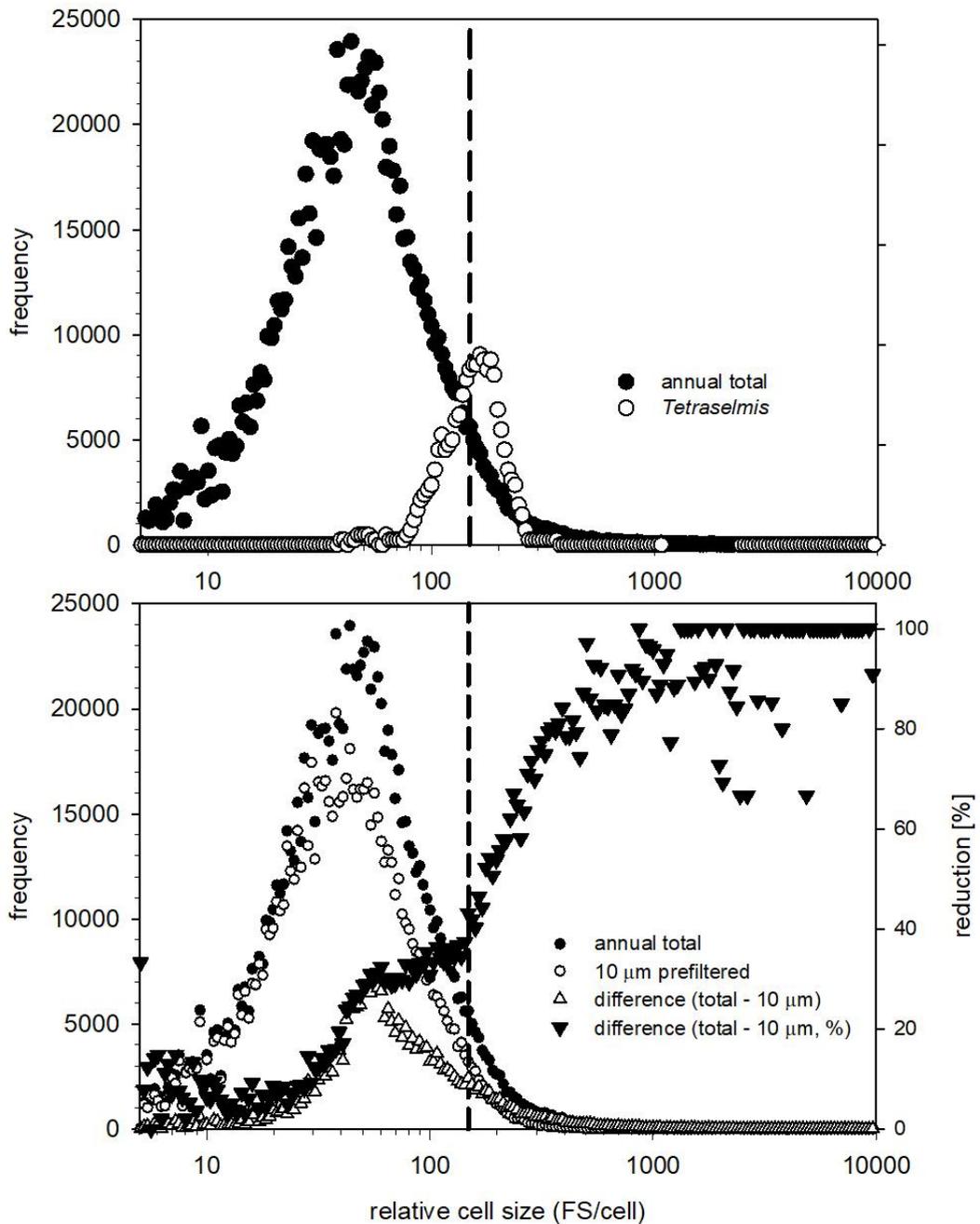


Fig. 9: Flow cytometric data of frequency distribution of phytoplankton cell size (2 - > 50 μm) of total phytoplankton (top graph), cells passing 10 μm mesh, numerical difference and percentage of difference between both data sets. Values are based on annually integrated numbers (below). Top graph is total phytoplankton and *Tetraselmis* sp. as a reference phytoplankton species. Dashed line indicates FS value corresponding with ESD of 10 μm.