The following supplement accompanies the article

Flows of biogenic carbon within marine pelagic food webs: roles of microbial competition switches

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Supplement. Description of the model and model runs

Partitioning of ingested carbon among food-web processes

This Section is largely adapted from Legendre & Rivkin (2008). Tables and equations with the 'S' designation are in this Supplement; those without are in the ,main paper. The notations used in this Supplement are listed in Table S1.

The food-web compartments below are those illustrated in Fig. 1: phytoplankton (PHYTO), particulate organic carbon produced by PHYTO (PHYTO-POC), dissolved organic carbon (DOC, from PHYTO and heterotrophic compartments), heterotrophic bacteria (BACT), microzooplankton (µZOO), mesozooplankton (MZOO), large heterotrophs (LARGE), and organic detrituc (DETR). In Fig. 1, the organic carbon that enters a food-web compartment is partitioned among several output flows. Ingestion (I) is the sum of the input flows into an individual heterotrophic compartment.(for BACT, I is called assimilation or uptake; see Fig. 2 of Legendre & Rivkin 2008). Part of I is assimilated (A) and the remainder is egested as particulate organic carbon (POC). Egestion of POC is typically in the form of fecal material (F), which will constitute a flow from a living compartment to DETR, and a proportion of DETR can be consumed (D). Assimilation, which is equivalent to the carbon demand for growth and metabolism, is partitioned among heterotrophic production (P; i.e. flow from a living compartment to another), heterotrophic respiration (R; i.e. flow from a living compartment to CO_2), and excretion of dissolved organic carbon (DOC) into the surrounding medium (E; i.e. flow from a living compartment to DOC). For a generic food-web compartment (subscript 'x'), I is partitioned between undigested materials (i.e. F) and A. Assimilation is further partitioned into P, R, and E:

$$I_x = A_x + F_x = (P_x + R_x + E_x) + F_x \quad \text{(S1)}$$

It follows that P is net of R and E (and F). We define F as the evacuation of ingested organic matter that has not been metabolized by the organisms, but has instead been repackaged as detrital POC (e.g. fecal material). In contrast, E is the release of dissolved organic matter (DOM), which is produced by the metabolism of organisms (e.g. urea, amino acids, DOC). From Eq. (S1):

$$A_x = P_x + R_x + E_x \quad \text{(S2)}$$

The dimensions of I, A, F, P, R, and E are time^{-1} in the case of specific rates, or (mass × volume^{-1} × time^{-1}) or (mass × area^{-1} × time^{-1}) for volumetric or areal rates, respectively.

Eqs. (S1 & S2) apply to metazoans. In the case of protozoans, F and E are generally not separated. For µZOO (subscript 'µz'), Eq. (S1) becomes:

$$I_{\mu z} = A_{\mu z} + E_{\mu z} = (P_{\mu z} + R_{\mu z}) + E_{\mu z} \quad \text{(S3)}$$

where $E_{\mu z}$ includes $F_{\mu z}$. Eq. (S3) is consistent with Straile (1997).

For osmotrophs, such as BACT (subscript 'b'), there is no egestion or excretion of non-metabolized organic matter (i.e. $F = 0$ and $E = 0$; hence $I_b = A_b$). In the literature, the terms 'assimilation' (A), 'uptake' (U), and 'incorporation' are often used interchangeably for BACT. Hence, Eqs. (S1 & S2) are rewritten as:

$$I_b = A_b = (U_b) = P_b + R_b \quad \text{(S4)}$$

In Eqs. (S1 & S2), I and A are related to P by growth efficiencies (e.g. Straile 1997). Net growth efficiency (NGE) and gross growth efficiency (GGE), i.e.:

$$NGE_x = P_x / A_x \quad (S5)$$

$$GGE_x = P_x / I_x \quad (S6)$$

are related by the assimilation efficiency (AE) as shown in Eqs. (S7 & S8):

$$AE_x = A_x / I_x \quad (S7)$$

hence:

$$GGE_x = AE_x \times NGE_x \quad (S8)$$

Because $AE_x < 1$, then $GGE_x < NGE_x$. NGE, GGE, and AE are dimensionless quantities.

Parameters of the reference model runs

In our steady-state model we used for the parameters (i.e. the between-compartment flows) values that were representative of field observations in the literature. The parameters for the reference model illustrated in Fig. 1 (reported in Table S2) were determined as described below. Our model considers the fate of the total primary production (PP_T, where PP_T is the sum of particulate and dissolved primary production: $PP_T = PP_P + PP_D$) that is respired within the euphotic zone, and hence is not exported from the euphotic zone (in the model, heterotrophic community respiration, $R_C = PP_T$). In our model, the parameter output flows from a compartment are expressed as proportion of the total input flow (i.e. A or I, which is the sum of the individual input flows) into that compartment, and the modeled flows are expressed as proportions of PP_T or R_C ($PP_T = R_C$). The content of this Section is adapted from Appendix 1 of Legendre & Rivkin (2008).

We partitioned PP_T between the particulate and dissolved fractions as PP_P:PP_D = 0.8:0.2, to reflect the published global median values reported in Legendre & Rivkin (2008, their Appendix 2), Hence, the value for the proportion of extracellular release (PER) was:

$$PER = PP_D / PP_T = 0.2 \quad (S9)$$

Three of the heterotrophic compartments, i.e. BACT, μZOO, and MZOO (corresponding subscripts: b, μz, and mz, respectively), were temperature (T)-dependent, i.e. their growth efficiencies were scaled to T. For the T-dependent parameters below, we provide both the T-dependent equations and the values at 15°C.

For the BACT compartment, we used the T-dependent bacterial growth efficiency (BGE) relationship of Rivkin & Legendre (2001). For 15°C:

$$\text{BGE} = 0.374 - 0.0104 \times \text{T} = 0.374 - 0.0104 \times 15 = 0.218 \quad \text{(S10)}$$

With Eq. S10, we computed the two T-dependent parameter flows from BACT, i.e., P_b/A_b and R_b/A_b:

$$P_b / A_b = \text{BGE} \quad \text{(S11)}$$

$$R_b / A_b = 1 - (P_b / A_b) = 1 - \text{BGE} \quad \text{(S12)}$$

For the µZOO compartment, we used the $\text{GGE}_{\mu z} = f(\text{T})$ relationship of Rivkin & Legendre (2001). For 15°C :

$$\text{GGE}_{\mu z} = 0.66 - 0.014 \times \text{T} = 0.66 - 0.014 \times 15 = 0.45 \quad \text{(S13)}$$

The 3 T-dependent parameter flows from µZOO are: $P_{\mu z}/I_{\mu z}$, $E_{\mu z}/I_{\mu z}$, and $R_{\mu z}/_{\mu}I_z$. Using Eq. (S13), we computed $P_{\mu z}/I_{\mu z}$:

$$P_{\mu z} / I_{\mu z} = \text{GGE}_{\mu z} \quad \text{(S14)}$$

Eq. (S14) is based on Eqs. (S6 & S13). Based on (Eq. 3), the sum of the two remaining µZOO parameters is $(E_{\mu z}/I_{\mu z}+R_{\mu z}/I_{\mu z}) = [1-(P_b/I_b)]$. To compute the individual values of the 2 parameters, we treated $E_{\mu z}/I_{\mu z}$ and $R_{\mu z}/I_{\mu z}$ as 2 parallel flows out of the µZOO compartment, i.e. we partitioned $[1-(P_b/I_b)]$ between $E_{\mu z}/(E_{\mu z}+R_{\mu z})$ and $R_{\mu z}/(E_{\mu z}+R_{\mu z})$. To obtain $E_{\mu z}/(E_{\mu z}+R_{\mu z})$, we assumed $R_{\mu z}/I_{\mu z}$ and $E_{\mu z}/I_{\mu z}$ values of 0.33 and 0.44, respectively (Pelegri et al. 1999, heterotrophic nanoflagellate *Pteridomonas danica* feeding on *Escherichia coli*). From these values, we calculated:

$$E_{\mu z} / (E_{\mu z} + R_{\mu z}) = 0.6 \quad \text{(S15)}$$

We computed the $E_{\mu z}/I_{\mu z}$ parameter as follows:

$$E_{\mu z} / I_{\mu z} = [E_{\mu z} / (E_{\mu z} + R_{\mu z})] \times (1 - P_{\mu z} / I_{\mu z}) \quad \text{(S16)}$$

Eq. (S16) is derived from Eq. (3). Using Eq. (S14 & S15), Eq. (S16) becomes:

$$E_{\mu z} / I_{\mu z} = 0.6 \times (1 - P_{\mu z} / I_{\mu z}) = 0.6 \times (1 - \text{GGE}_{\mu z}) \quad \text{(S17)}$$

We checked the general applicability of 0.6 value in Eqs. (S15 and S17) by comparing the corresponding $E_{\mu z}/I_{\mu z}$ with those reported (1) by Strom et al. (1997; their Fig. 4) for a ciliate feeding on a flagellate at 12ºC (i.e. $E_{\mu z}/I_{\mu z} \geq 0.3$; experimental results corrected for BACT consumption of DOC with BGE = 0.25), and (2) by Nagata (2000) based on a survey of the literature (i.e. $0.1 < E_{\mu z}/I_{\mu z} < 0.3$). To obtain $E_{\mu z}/I_{\mu z}$ needed for the comparison with Strom et al. (1997) and Nagata (2000), we computed $E_{\mu z}/I_{\mu z}$ at 12ºC (i.e. the temperature in Strom et al. 1997) corresponding to Eq. (S15) by combining Eqs. (S13 & S14) which gave $(R_{\mu z}+E_{\mu z})/I_{\mu z} = 0.5$. In order to obtain $E_{\mu z}/I_{\mu z}$ we entered this $(R_{\mu z}+E_{\mu z})/I_{\mu z} = 0.5 = (1-P_{\mu z}/I_{\mu z})$ (Eq. S3) in Eq. (S16), which gave $E_{\mu z}/I_{\mu z} = 0.3$. The latter value is at the low and high ends of the ranges of $E_{\mu z}/I_{\mu z}$ reported by Strom et al. (1997) and Nagata (2000), respectively, suggesting that the 0.6 value from Pelegri et al. (1999) is generally applicable.

We computed the $R_{\mu z}/I_{\mu z}$ parameter as:

$$R_{\mu z} / I_{\mu z} = 1 - (P_{\mu z} / I_{\mu z} + E_{\mu z} / I_{\mu z}) = 0.4 \times (1 - \text{GGE}_{\mu z}) \quad \text{(S18)}$$

Eq. (S18) combines Eqs. (S3, S14 and S17).

For the MZOO compartment, we computed the parameter flow to DETR using AE_{mz} = 0.7 of Ikeda & Motoda (1978):

$$F_{mz} / I_{mz} = 1 - \text{AE}_{mz} = 0.3 \quad \text{(S19)}$$

Eq. (S19) combines Eqs. (S1 & S7). The 3 other MZOO parameters were made T-dependent by using the $\text{NGE}_{mz} = f(\text{T})$ relationship based on the NGE values for large zooplankton in Legendre & Rivkin (2005; their Table 4, column LZ):

$$\text{NGE}_{mz} = 0.40 - 0.003 \times \text{T} = 0.40 - 0.003 \times 15 = 0.355 \quad \text{(S20)}$$

The 3 T-dependent parameter flows from MZOO are: P_{mz}/I_{mz}, E_{mz}/I_{mz}, and R_{mz}/I_{mz}. We computed the P_{mz}/I_{mz} parameter as follows:

$P_{mz} / I_{mz} = GGE_{mz} = NGE_{mz} \times AE_{mz} = 0.355 \times 0.7 = 0.2485$ (S21)

Equation (S21) is based on Eq. (S5 to S8 & S20). For the parameter E_{mz}/I_{mz}, we used the $E_{mz}/I_{mz} = 0.15$ at 15°C, which is at the lower end of the range of E_{mz}/I_{mz} reported by Strom et al. (1997; their Fig. 4) for a copepod feeding on PHYTO at 12ºC (i.e. $E_{mz}/I_{mz} \geq 0.15$; experimental results corrected for BGE = 0.25), and within the range reported by Nagata (2000; i.e., $0.1 < E_{mz}/I_{mz} < 0.2$). In order to treat E_{mz}/I_{mz} in the same way as the $E_{\mu z}/I_{\mu z}$ parameter, i.e. Eq. (S16), we first expressed E_{mz} as a fraction of (E_{mz}+R_{mz}). Using Eqs. (S2, S5 & S7), it can be shown that:

$E_{mz} / (E_{mz} + R_{mz}) = (E_{mz} / A_{mz}) / (1 - NGE_{mz}) = [(E_{mz} / I_{mz}) / AE_{mz}] / (1 - NGE_{mz})$

(S22)

Because $E_{mz}/I_{mz} = 0.15$, $AE_{mz} = 0.7$ and $NGE_{mz} = 0.36$ at 15°C , i.e. Eq. (S20), Eq. (S22) resolves to:

$E_{mz} / (E_{mz} + R_{mz}) = 0.33$ (S23)

The equation for the E_{mz}/I_{mz} parameter is equivalent to Eq. (S16) for µZOO:

$E_{mz} / I_{mz} = AE_{mz} \times [E_{mz} / (E_{mz} + R_{mz})] \times (1 - P_{mz}/A_{mz}) = [E_{mz} / (E_{mz} + R_{mz})] \times (AE_{mz} - P_{mz}/I_{mz})$ (S24)

Eq. (S24) is derived from Eqs. (S2, S7 & S23). Given Eq. (S23), $AE_{mz} = 0.7$, and $P_{mz}/A_{mz} = NGE_{mz}$, i.e. Eq. (S5), Eq. (S24) becomes:

$E_{mz} / I_{mz} = 0.23 \times (1 - NGE_{mz}) = 0.33 \times (0.7 - P_{mz}/I_{mz})$ (S25)

The equation for the R_{mz}/I_{mz} parameter is parallel to Eq. (S18) for µZOO:

$R_{mz} / I_{mz} = 1 - (F_{mz} / I_{mz} + P_{mz} / I_{mz} + E_{mz} / I_{mz})$ (S26)

Eq. (S26) combines Eqs. (S3, S19, S21 & S25).

Heterotrophic components of the planktonic food web consume varying amounts of DETR. In our model, there are 2 consumption pathways of DETR: use by BACT of DOC both leaking from fecal pellets and resulting from hydrolysis of particles (including fecal material) by bacterial exoenzymes, and filter feeding of DERT by MZOO. Given these 2 pathways, we partitioned DETR consumption (D) between BACT and MZOO (D_b/D, and D_{mz}/D, respectively) as follows:

$$D_b/D = 0.6, \text{ and } D_{mz}/D = 0.4 \qquad \text{(S27)}$$

Although filter-feeding µZOO are likely to ingest small-sized DETR, we did not include this process in the model because the quantitative use of DETR as food by µZOO is not known.

For the last food-web compartment, i.e. LARGE, respiration was set to R_{lg}/I_{lg} =1.0 by model construction.

In all cases, the flow from the PHYTO-POC to DETR was:

$$PP_{Pd}/PP_P = 0.2 \qquad \text{(S28)}$$

However, there were 2 different food webs modeled, i.e. microbial and herbivorous (MFW and HFW, respectively), and the difference in parameterization between the 2 food webs was in their respective flows from PHYTO-POC to µZOO ($PP_{P\mu z}$) and to MZOO (PP_{Pmz}). For the MFW:

$$PP_{P\mu Z} / PP_P = 0.72, \text{ and conversely } PP_{Pmz}/PP_P = 0.08 \qquad \text{(S29)}$$

and for the HFW:

$$PP_{P\mu Z} / PP_P = 0.2, \text{ and conversely } PP_{Pmz}/PP_P = 0.6 \qquad \text{(S30)}$$

The origin of $PP_{P\mu Z}/PP_P$ = 0.72, and 0.2 for the MFW and the HFW, respectively, is explained in the main text (Section “Model runs”). The fraction of non-detrital PP_P ($PP_{Pnd} = PP_P - PP_{Pd}$) ingested by µZOO (e.g. dinoflagellates) as large-sized cells ($PP_{PL\mu Z}/PP_{Pnd}$) was set, in the reference runs, to:

$$PP_{PL\mu Z} / PP_{Pnd} = 0.2 \qquad \text{(S31)}$$

Hence:

$$PP_{P\mu Z} / PP_P = [(PP_{PL\mu Z} / PP_{Pnd}) \times (PP_{Pnd} / PP_P)] + PP_{PS\mu Z} / PP_P \qquad \text{(S32)}$$

For the MFW

$$0.72 = [(PP_{PL\mu Z} / \mathrm{PP}_{Pnd}) \times 0.8] + 0.56 = 0.16 + 0.56 \quad \text{(S33)}$$

For the HFW:

$$0.2 = [(PP_{PL\mu Z} / \mathrm{PP}_{Pnd}) \times 0.8] + 0.04 = 0.16 + 0.04 \quad \text{(S34)}$$

Model equations

This section presents the modeled output flows, which were expressed as proportions of PP_T or R_C ($PP_T = R_C$). Each modeled output flow was expressed as a linear function of the relevant flow parameters. As stated above, we assumed that compartments were in steady state.

Transforming Eq. (S9) provides the numerical input values of PP_D/PP_T and PP_P/PP_T:

$$PP_D/PP_T = \mathrm{PER} = 0.2\text{, and } PP_P/PP_T = (1 - \mathrm{PER}) = 0.8 \quad \text{(S35)}$$

Combining Eqs. (S28, S35, S41, S44, S47) gives the equation for BACT assimilation:

$$A_b/PP_T = PP_D/PP_T + E_{\mu z}/PP_T + E_{mz}/PP_T + [(PP_P/PP_T \times PP_{de}/PP_P) + F_{mz}/PP_T] \times D_b/D = 0.2 + E_{\mu z}/PP_T + E_{mz}/PP_T + [(0.8 \times 0.2) + F_{mz}/PP_T] \times 0.6 \quad \text{(S36)}$$

Combining Eqs. (S10, S11 & S36) gives the equation for BACT production:

$$P_b/PP_T = A_b/PP_T \times P_b/A_b = A_b/PP_T \times \mathrm{BGE} = A_b/PP_T \times 0.218 \quad \text{(S37)}$$

Combining Eqs. (S10, S12 & S36) gives the equation for BACT respiration:

$$R_b/PP_T = A_b/PP_T \times R_b/A_b = A_b/PP_T \times (1 - \mathrm{BGE}) = A_b/PP_T \times (1 - 0.218) \quad \text{(S38)}$$

Combining Eqs. (S29, S30, S35 & S37) gives the equation for µZOO ingestion:

$$I_{\mu z}/PP_T = (PP_P/PP_T \times PP_{P\mu Z}/PP_P) + P_b/PP_T = (0.8 \times PP_{P\mu Z}/PP_P) + P_b/PP_T \quad \text{(S39)}$$

Combining Eqs. (S13, S14 & S39) gives the equation for µZOO production:

$$P_{\mu z}/PP_T = I_{\mu z}/PP_T \times P_{\mu z}/I_{\mu z} = I_{\mu z}/PP_T \times \mathrm{GGE}_{\mu z} = I_{\mu z}/PP_T \times 0.45 \quad \text{(S40)}$$

Combining Eqs. (S13, S17 & S39) gives the equation for µZOO excretion:

$$E_{\mu z}/PP_T = I_{\mu z}/PP_T \times E_{\mu z}/I_{\mu z} = I_{\mu z}/PP_T \times 0.6 \times (1 - \mathrm{GGE}_{\mu z}) = I_{\mu z}/PP_T \times 0.33 \quad \text{(S41)}$$

Combining Eqs. (S13, S18 & S39) gives the equation for µZOO respiration:

$$R_{\mu z}/PP_T = I_{\mu z}/PP_T \times R_{\mu z}/I_{\mu z} = I_{\mu z}/PP_T \times 0.4 \times (1 - \mathrm{GGE}_{\mu z}) = I_{\mu z}/PP_T \times 0.22 \quad \text{(S42)}$$

Combining Eqs. (S27, S28, S29, S35, S40, S44) gives the equation for MZOO ingestion:

I_{mz}/PP_T = $\{[(PP_P/PP_T \text{ x } PP_{de}/PP_P) + F_{mz}/PP_T\,] \text{ x } D_{mz}/D\} + (PP_P/PP_T \text{ x } PP_{Pmz}/PP_P) + P_{\mu z}/PP_T = \{[(0.8 \text{ x } 0.2) + F_{mz}/PP_T\,] \text{ x } D_{mz}/D\} + (0.8 \text{ x } PP_{Pmz}/PP_P) + P_{\mu z}/PP_T$ (S43)

Combining Eqs. (S19, S43) gives the equation for MZOO egestion:

$F_{mz}/PP_T = I_{mz}/PP_T \text{ x } F_{mz}/I_{mz} = I_{mz}/PP_T \text{ x } 0.3$ (S44)

Combining Eqs. (S43, S44) gives the equation for MZOO assimilation:

$A_{mz}/PP_T = I_{mz}/PP_T - F_{mz}/PP_T$ (S45)

Combining Eqs. (S21, S43) gives the equation for MZOO production:

$P_{mz}/PP_T = I_{mz}/PP_T \text{ x } P_{mz}/I_{mz} = I_{mz}/PP_T \text{ x } 0.2485$ (S46)

Combining Eqs. (S24, S25, S43) gives the equation for MZOO excretion:

$E_{mz}/PP_T = I_{mz}/PP_T \text{ x } E_{mz}/I_{mz} = I_{mz}/PP_T \text{ x } 0.15$ (S47)

Combining Eqs. (S19, S21, S24, S25, S26, S43) gives the equation for MZOO respiration:

$R_{mz}/PP_T = I_{mz}/PP_T \text{ x } R_{mz}/I_{mz} = I_{mz}/PP_T \text{ x } [1 - (F_{mz}/I_{mz} + P_{mz}/I_{mz} + E_{mz}/I_{mz}) = I_{mz}/PP_T \text{ x } [1 - (0.3 + 0.2485 + 0.15)] = I_{mz}/PP_T \text{ x } 0.3015$ (S48)

Using Eq. (S46) gives the equation for the ingestion of LARGE:

$I_{lg}/PP_T = P_{mz}/PP_T$ (S49)

Using Eq. (S49) gives the equation for the production of LARGE:

$P_{lg}/PP_T = I_{lg}/PP_T \text{ x } (1 - R_{lg}/I_{lg})$ (S50)

where R_{lg}/I_{lg} =1.0 by model construction (previous Section). Hence:

$P_{lg}/PP_T = I_{lg}/PP_T \text{ x } (1 - 1) = 0$ (S51)

Using Eq. (S49) gives the equation for the respiration of LARGE:

$R_{lg}/PP_T = I_{lg}/PP_T \text{ x } R_{lg}/I_{lg}$ (S52)

where R_{lg}/I_{lg} =1.0 by model construction (previous Section). Hence:

$P_{lg}/PP_T = I_{lg}/PP_T \text{ x } 1 = I_{lg}/PP_T$ (S53)

Parameters and calculation of the competition model runs

The parameters used to assess the effects of competition switches are given in Table S2. The procedure is summarised here.

For model runs that tested the competition switch PB, parameter PER was changed from 0.2 in the reference runs to 0.1 and 0.3 in runs with 50% less (L) and 50% more (M) competition, respectively.

For model runs that tested the competition switch MB, parameter D_b/D was changed by 50% from 0.6 in the reference run to 0.3 and 0.9 in runs L and M, respectively. Because $D = D_b + D_{mz}$, parameter D_{mz}/D was changed from 0.4 in the reference run to 1.0 – 0.3 = 0.7 and 1.0 – 0.9 = 0.1 in runs L and M, respectively.

For model runs that involved the competition switch Mμ, $PP_{PL\mu Z}/PP_{Pnd}$ was changed by 50% from 0.2 in the reference runs (Eq. (S30)) to 0.1 and 0.3 in runs L and M, respectively. It follows, given Eqs. (S33 & S34), that $PP_{P\mu Z}/PP_P$ for the MFW was changed from 0.72 in the reference runs to 0.64 and 0.80 in runs L and M, respectively, and was changed for the HFW from 0.2 in the reference run to 0.12 and 0.28 in runs L and M, respectively.

In model runs that involved 2 competition switches or the 3 of them, changes were made in the 2 or 3 corresponding parameters.

Computation of steady-state solutions

The steady-state solution for each model run was computed as follows. Each modeled output flow was expressed as a linear function of the relevant flow parameters, and all flow equations were written in successive cells in the same row of a Microsoft Excel spreadsheet. Because there are backward flows in the model (i.e. *E* and *F*; Figs. 1 & 5), the steady-state solution required multiple iterations. This was achieved by activating the "Iteration" feature of Excel (up to 1000 iterations). All output flows corresponding to the steady-state solution were thus modeled simultaneously.

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Table S1. Notations for the variables, flows of organic carbon (parameter and modeled flows; italic letters), and subscripts used in the present Supplement. Some were already given in text Table 1.

Notation	Variable, model parameter, model flow
A	Assimilation
AE	Assimilation efficiency
BACT	Bacteria
BGE	Bacterial growth efficiency
D	Detritus consumption
DETR	Detritus (POC)
DOC	Dissolved organic carbon
DOM	Dissolved organic matter
E	Excretion
F	Egestion (fecal material)
GGE	Gross growth efficiency
I	Ingestion
LARGE	Large heterotrophs
MZOO	Mesozooplankton
μZOO	Microzooplankton
NGE	Net growth efficiency
P	Production (heterotrophic)
PER	Percentage of extracellular release
PHYTO	Phytoplankton
PHYTO-POC	Particulate organic carbon produced by PHYTO
POC	Particulate organic carbon
PP	Primary production[a]
R	Respiration
T	Temperature
U	Uptake

Subscript	Meaning
b	Bacteria (heterotrophic)
lg	Large heterotrophs
mz	Mesozooplankton
μz	Microzooplankton
x	Heterotrophic food-web compartment
C	Heterotrophic community
D	Dissolved (*PP*)
DOC	Dissolved organic carbon
P	Particulate (*PP*)
Pmz	PP_P consumed by MZOO
Pd	Phytodetritus from PP_P
PLμz	Large-sized PP_P consumed by μZOO
Pnd	Non-detrital PP_P
PSμz	Small-sized PP_P consumed by μZOO
Pμz	PP_P consumed by μZOO
T	Total (PP) = D + P

[a]In our model, PP is primary production that is respired in the euphotic zone, i.e. that is not exported

Table S2. Values of the parameters used in the reference and competition switch model runs for the microbial and herbivorous food webs. Bold italics: parameter values that were changed to test the effects of increasing (M) or decreasing (L) competition intensity for one or more of the competition switches. The values of the T-dependent parameters (i.e. P_b/A_b, R_b/A_b, $E_{\mu z}/I_{\mu z}$, $P_{\mu z}/I_{\mu z}$, $R_{\mu z}/I_{\mu z}$, F_{mz}/I_{mz}, E_{mz}/I_{mz}, P_{mz}/I_{mz}, R_{mz}/I_{mz}) correspond to 15°C.

Parameter	Reference runs		Switch PB		Switch MB		Switch Mμ			
	MFW	HFW	MFW and HFW		MFW and HFW		MFW		HFW	
			Runs L	Runs M	Runs L	Runs M	Runs L	Runs M	Runs L	Runs M
PER	0.200	0.200	***0.100***	***0.300***	0.200	0.200	0.200	0.200	0.200	0.200
P_b/A_b	0.218	0.218	0.218	0.218	0.218	0.218	0.218	0.218	0.218	0.218
R_b/A_b	0.782	0.782	0.782	0.782	0.782	0.782	0.782	0.782	0.782	0.782
D_b/D	0.600	0.600	0.600	0.600	***0.300***	***0.900***	0.600	0.600	0.600	0.600
D_{mz}/D	0.400	0.400	0.400	0.400	***0.700***	***0.100***	0.400	0.400	0.400	0.400
R_{lg}/I_{lg}	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
$E_{\mu z}/I_{\mu z}$	0.330	0.330	0.330	0.330	0.330	0.330	0.330	0.330	0.330	0.330
$P_{\mu z}/I_{\mu z}$	0.450	0.450	0.450	0.450	0.450	0.450	0.450	0.450	0.450	0.450
$R_{\mu z}/I_{\mu z}$	0.220	0.220	0.220	0.220	0.220	0.220	0.220	0.220	0.220	0.220
F_{mz}/I_{mz}	0.300	0.300	0.300	0.300	0.300	0.300	0.300	0.300	0.300	0.300
E_{mz}/I_{mz}	0.148	0.148	0.148	0.148	0.148	0.148	0.148	0.148	0.148	0.148
P_{mz}/I_{mz}	0.249	0.249	0.249	0.249	0.249	0.249	0.249	0.249	0.249	0.249
R_{mz}/I_{mz}	0.303	0.303	0.303	0.303	0.303	0.303	0.303	0.303	0.303	0.303
PP_{Pd}/PP_{TP}	0.200	0.200	0.200	0.200	0.200	0.200	0.200	0.200	0.200	0.200
$PP_{PL\mu Z}/PP_{nd}$	0.200	0.200	0.200	0.200	0.200	0.200	***0.100***	***0.300***	***0.100***	***0.300***
$PP_{P\mu z}/PP_p$	0.720	0.200	0.720	0.200	0.720	0.200	***0.640***	***0.800***	***0.120***	***0.280***
PP_{Pmz}/PP_p	0.080	0.600	0.080	0.600	0.080	0.600	***0.160***	***0.000***	***0.680***	***0.520***