*The following supplements accompany the article*

# Carbon transfer in herbivore- and microbial loop-dominated pelagic food webs in the southern Barents Sea during spring and summer

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**Supplement 1. Additional figures and tables**

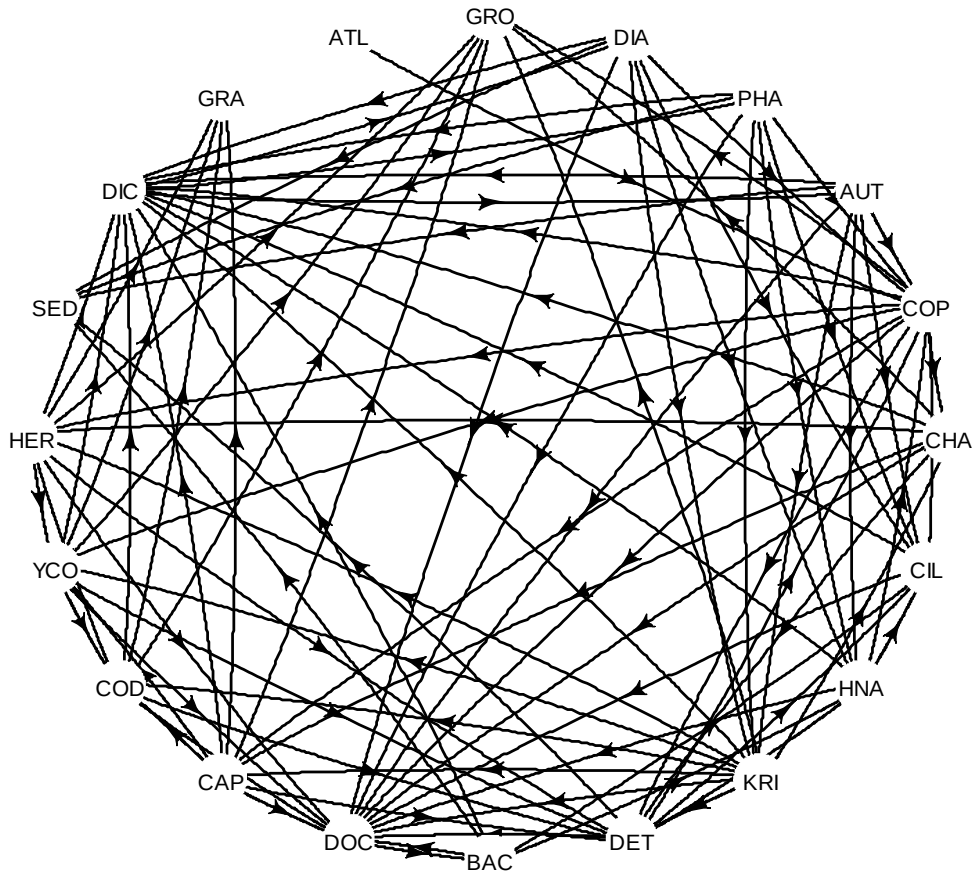


**Fig. S1. Compartments, externals and flows (arrows) of the southern Barents Sea food web. Externals are Atlantic current (ATL), growth (GRO), sedimentation (SED), dissolved inorganic carbon (DIC), grazing by higher trophic levels, including man (GRA). Compartments are diatoms (DIA), *Phaeocystis* sp. (PHA), autotrophic pico- and nanoplankton (AUT), copepods (COP), chaeotognaths (CHA), ciliates (CIL), heterotrophic flagellates (HNA), krill (KRI), detritus (DET), bacteria (BAC), dissolved organic carbon (DOC), capelin (CAP), adult cod (COD), young cod (YCO), herring (HER)**

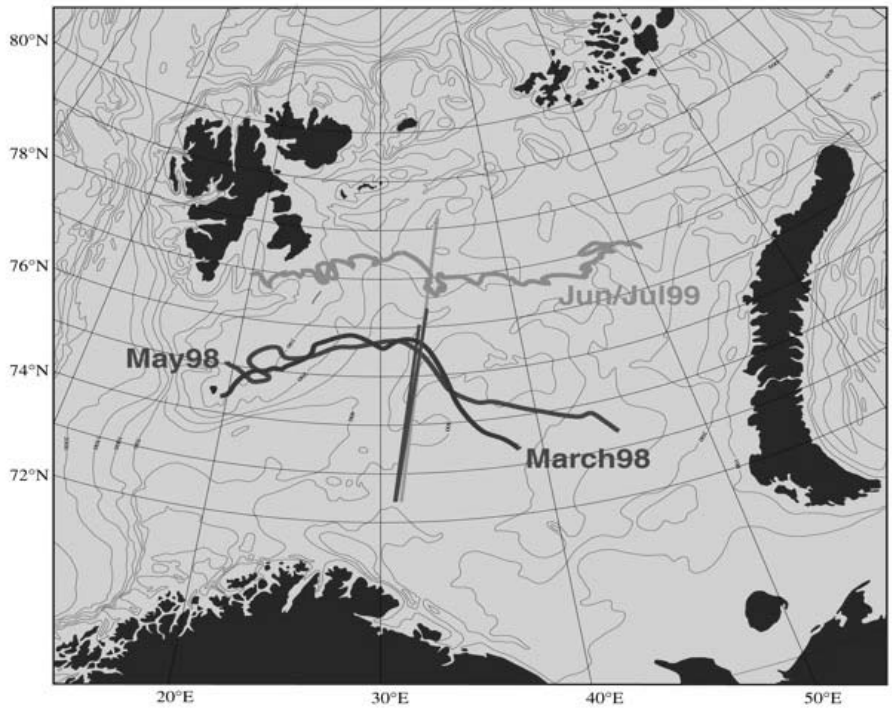


**Fig. S2. The Barents Sea, with horizontal lines denoting the maximal seasonal extent of the ice cover and vertical lines representing the transects along which the data in Wassmann (2002) were sampled. Only data were considered from those parts of the transects that were never covered by ice**

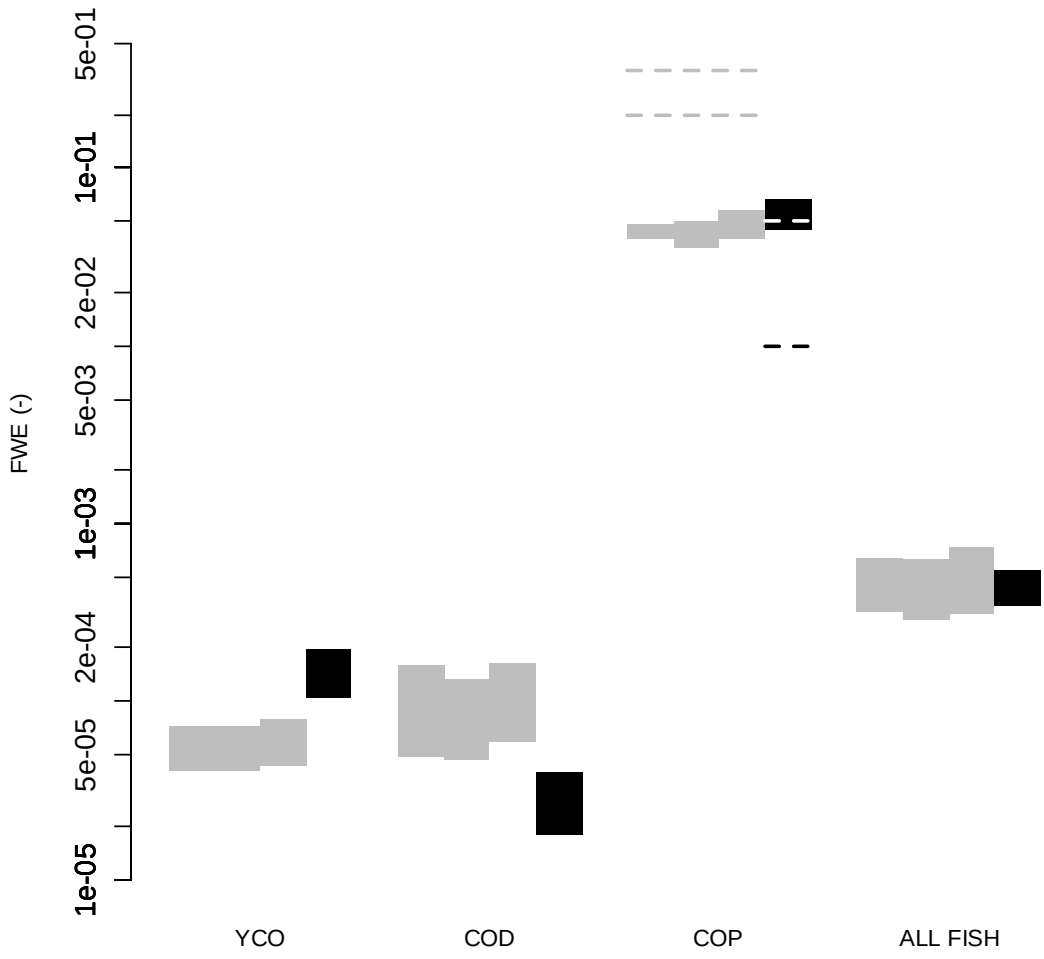


**Fig. S3. Food web efficiency (FWE, expressed as a proportion) calculated as the production of young cod (YCO), adult cod (COD), copepods (COP) and all fish (ALL FISH), divided by the sum of net primary production and input of copepod biomass by the Atlantic current minus sedimentation losses. Dashed lines are FWEs for copepod production found by Berglund et al. (2007)**

**Table S1. Food web matrix specifying the links between the food web compartments where rows represent sources and columns represent sinks.**

| | | to | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | DIA | PHA | AUT | COP | CHA | CIL | HNA | KRI | DET | BAC | DOC | CAP | COD | YCO | HER | SED | DIC | GRA | ATL | GRO |
| from | DIA | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 |
| | PHA | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 |
| | AUT | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 |
| | COP | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 0 | 0 | 1 |
| | CHA | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 1 |
| | CIL | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| | HNA | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| | KRI | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 0 | 0 | 1 |
| | DET | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 |
| | BAC | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 |
| | DOC | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | CAP | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 1 | 1 | 0 | 0 | 1 | 1 | 0 | 1 |
| | COD | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 1 |
| | YCO | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 1 |
| | HER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 1 | 1 | 0 | 0 | 1 | 1 | 0 | 1 |
| | SED | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | DIC | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | GRA | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | ATL | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | GRO | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

**Table S2. *lp* ranges for the carbon flows in the four food web structures: minima and maxima (g C $m^{-2}$ $d^{-1}$).**

| | spring HF0 | | spring HF50 | | spring HF100 | | summer | |
|---|---|---|---|---|---|---|---|---|
| | **min** | **max** | **min** | **max** | **min** | **max** | **min** | **max** |
| **DIC->PHA** | 7.22E-01 | 4.12E+00 | 7.22E-01 | 4.48E+00 | 7.22E-01 | 4.85E+00 | 1.32E-01 | 2.06E+00 |
| **PHA->COP** | 0.00E+00 | 2.50E-01 | 0.00E+00 | 2.47E-01 | 0.00E+00 | 2.44E-01 | 0.00E+00 | 1.99E-01 |
| **PHA->CIL** | 0.00E+00 | 2.99E-01 | 0.00E+00 | 3.02E-01 | 0.00E+00 | 3.02E-01 | 0.00E+00 | 5.76E-01 |
| **PHA->HNA** | 0.00E+00 | 0.00E+00 | 0.00E+00 | 6.56E-01 | 0.00E+00 | 7.58E-01 | 0.00E+00 | 5.76E-01 |
| **PHA->KRI** | 0.00E+00 | 1.20E-03 | 0.00E+00 | 1.20E-03 | 0.00E+00 | 1.20E-03 | 0.00E+00 | 7.52E-04 |
| **PHA->SED** | 6.00E-01 | 8.00E-01 | 6.00E-01 | 8.00E-01 | 6.00E-01 | 8.00E-01 | 0.00E+00 | 2.36E-01 |
| **PHA->DIC** | 3.61E-02 | 1.24E+00 | 3.61E-02 | 1.35E+00 | 3.61E-02 | 1.46E+00 | 6.58E-03 | 6.17E-01 |
| **PHA->DOC** | 8.57E-02 | 1.73E+00 | 8.57E-02 | 1.88E+00 | 8.57E-02 | 2.04E+00 | 6.79E-02 | 8.64E-01 |
| **DIC->DIA** | 3.47E-01 | 2.37E+00 | 3.47E-01 | 2.81E+00 | 3.47E-01 | 3.18E+00 | 1.58E-01 | 2.09E+00 |
| **DIA->COP** | 0.00E+00 | 2.50E-01 | 0.00E+00 | 2.47E-01 | 0.00E+00 | 2.44E-01 | 0.00E+00 | 1.99E-01 |
| **DIA->CIL** | 0.00E+00 | 3.01E-01 | 0.00E+00 | 3.02E-01 | 0.00E+00 | 3.02E-01 | 0.00E+00 | 5.86E-01 |
| **DIA->HNA** | 0.00E+00 | 0.00E+00 | 0.00E+00 | 7.38E-01 | 0.00E+00 | 8.40E-01 | 0.00E+00 | 5.86E-01 |
| **DIA->KRI** | 0.00E+00 | 1.20E-03 | 0.00E+00 | 1.20E-03 | 0.00E+00 | 1.20E-03 | 0.00E+00 | 7.52E-04 |
| **DIA->SED** | 5.00E-02 | 1.50E-01 | 5.00E-02 | 1.50E-01 | 5.00E-02 | 1.50E-01 | 0.00E+00 | 2.36E-01 |
| **DIA->DIC** | 1.74E-02 | 7.11E-01 | 1.74E-02 | 8.44E-01 | 1.74E-02 | 9.54E-01 | 7.89E-03 | 6.28E-01 |
| **DIA->DOC** | 4.13E-02 | 9.95E-01 | 4.13E-02 | 1.18E+00 | 4.13E-02 | 1.34E+00 | 8.29E-02 | 8.79E-01 |
| **DIC->AUT** | 5.66E-01 | 2.74E+00 | 2.96E-01 | 2.74E+00 | 2.54E-02 | 6.89E-01 | 4.32E-01 | 2.46E+00 |
| **AUT->COP** | 0.00E+00 | 2.50E-01 | 0.00E+00 | 2.47E-01 | 0.00E+00 | 2.44E-01 | 0.00E+00 | 1.99E-01 |
| **AUT->CIL** | 0.00E+00 | 3.01E-01 | 0.00E+00 | 3.02E-01 | 0.00E+00 | 3.02E-01 | 0.00E+00 | 6.90E-01 |
| **AUT->HNA** | 0.00E+00 | 0.00E+00 | 0.00E+00 | 7.68E-01 | 0.00E+00 | 4.22E-01 | 0.00E+00 | 6.90E-01 |
| **AUT->KRI** | 0.00E+00 | 1.20E-03 | 0.00E+00 | 1.20E-03 | 0.00E+00 | 1.20E-03 | 0.00E+00 | 7.52E-04 |
| **AUT->SED** | 0.00E+00 | 7.68E-01 | 0.00E+00 | 7.68E-01 | 0.00E+00 | 4.22E-01 | 0.00E+00 | 2.36E-01 |
| **AUT->DIC** | 2.83E-02 | 8.23E-01 | 1.48E-02 | 8.23E-01 | 1.27E-03 | 2.07E-01 | 2.16E-02 | 7.39E-01 |
| **AUT->DOC** | 6.72E-02 | 1.15E+00 | 3.51E-02 | 1.15E+00 | 3.01E-03 | 2.89E-01 | 2.39E-01 | 1.04E+00 |
| **HNA->COP** | 0.00E+00 | 0.00E+00 | 0.00E+00 | 2.50E-01 | 0.00E+00 | 2.50E-01 | 0.00E+00 | 4.15E-01 |
| **HNA->CIL** | 0.00E+00 | 0.00E+00 | 0.00E+00 | 3.02E-01 | 0.00E+00 | 3.02E-01 | 0.00E+00 | 1.91E+00 |
| **HNA->DIC** | 0.00E+00 | 0.00E+00 | 2.02E-01 | 1.71E+00 | 4.05E-01 | 1.71E+00 | 2.56E-01 | 1.39E+00 |
| **HNA->DOC** | 0.00E+00 | 0.00E+00 | 6.68E-02 | 1.35E+00 | 1.34E-01 | 1.35E+00 | 2.56E-01 | 1.39E+00 |
| **CHA->CAP** | 0.00E+00 | 2.20E-03 | 0.00E+00 | 2.20E-03 | 0.00E+00 | 2.20E-03 | 0.00E+00 | 0.00E+00 |
| **CHA->HER** | 0.00E+00 | 1.39E-03 | 0.00E+00 | 1.39E-03 | 0.00E+00 | 1.39E-03 | 0.00E+00 | 1.39E-03 |
| **CHA->DIC** | 1.38E-02 | 1.76E-02 | 1.38E-02 | 1.76E-02 | 1.38E-02 | 1.76E-02 | 1.77E-03 | 2.26E-03 |
| **CHA->DOC** | 9.96E-03 | 1.76E-02 | 9.96E-03 | 1.76E-02 | 9.96E-03 | 1.76E-02 | 1.28E-03 | 2.26E-03 |
| **CHA->DET** | 1.20E-02 | 2.67E-02 | 1.20E-02 | 2.67E-02 | 1.20E-02 | 2.67E-02 | 1.54E-03 | 3.43E-03 |
| **CHA->GRO** | 1.01E-02 | 2.71E-02 | 1.01E-02 | 2.71E-02 | 1.01E-02 | 2.71E-02 | 3.66E-04 | 3.49E-03 |
| **ATL->COP** | 0.00E+00 | 1.18E-01 | 0.00E+00 | 1.18E-01 | 0.00E+00 | 1.18E-01 | 0.00E+00 | 7.87E-02 |
| **COP->CHA** | 6.92E-02 | 8.89E-02 | 6.92E-02 | 8.89E-02 | 6.92E-02 | 8.89E-02 | 8.90E-03 | 1.14E-02 |
| **COP->CAP** | 0.00E+00 | 2.20E-03 | 0.00E+00 | 2.20E-03 | 0.00E+00 | 2.20E-03 | 0.00E+00 | 0.00E+00 |
| **COP->HER** | 0.00E+00 | 1.39E-03 | 0.00E+00 | 1.39E-03 | 0.00E+00 | 1.39E-03 | 0.00E+00 | 1.39E-03 |
| **COP->YCO** | 0.00E+00 | 1.76E-03 | 0.00E+00 | 1.76E-03 | 0.00E+00 | 1.76E-03 | 1.99E-04 | 9.45E-04 |
| **COP->DET** | 8.36E-02 | 1.25E-01 | 8.36E-02 | 1.25E-01 | 8.36E-02 | 1.25E-01 | 1.75E-01 | 2.10E-01 |
| **COP->DIC** | 2.68E-02 | 6.80E-02 | 2.68E-02 | 6.80E-02 | 2.68E-02 | 6.80E-02 | 3.91E-02 | 5.68E-02 |
| **COP->DOC** | 8.86E-03 | 6.80E-02 | 8.86E-03 | 6.80E-02 | 8.86E-03 | 6.80E-02 | 3.91E-02 | 5.68E-02 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **COP->GRO** | 0.00E+00 | 3.07E-02 | 0.00E+00 | 3.07E-02 | 0.00E+00 | 3.07E-02 | 4.75E-02 | 1.58E-01 |
| **CIL->COP** | 5.24E-04 | 1.81E-01 | 5.24E-04 | 1.81E-01 | 5.24E-04 | 1.81E-01 | 3.87E-03 | 4.21E-01 |
| **CIL->DIC** | 3.55E-03 | 2.05E-01 | 3.55E-03 | 2.05E-01 | 3.55E-03 | 2.05E-01 | 2.68E-02 | 1.14E+00 |
| **CIL->DOC** | 1.17E-03 | 1.36E-01 | 1.17E-03 | 1.36E-01 | 1.17E-03 | 1.36E-01 | 8.04E-03 | 1.12E+00 |
| **KRI->CHA** | 0.00E+00 | 4.59E-04 | 0.00E+00 | 4.59E-04 | 0.00E+00 | 4.59E-04 | 0.00E+00 | 6.80E-05 |
| **KRI->CAP** | 0.00E+00 | 4.59E-04 | 0.00E+00 | 4.59E-04 | 0.00E+00 | 4.59E-04 | 0.00E+00 | 0.00E+00 |
| **KRI->COD** | 2.09E-05 | 4.80E-04 | 2.09E-05 | 4.80E-04 | 2.09E-05 | 4.80E-04 | 2.33E-04 | 3.01E-04 |
| **KRI->HER** | 0.00E+00 | 4.59E-04 | 0.00E+00 | 4.59E-04 | 0.00E+00 | 4.59E-04 | 0.00E+00 | 6.80E-05 |
| **KRI->YCO** | 0.00E+00 | 4.59E-04 | 0.00E+00 | 4.59E-04 | 0.00E+00 | 4.59E-04 | 0.00E+00 | 6.80E-05 |
| **KRI->DET** | 1.49E-05 | 6.00E-04 | 1.49E-05 | 6.00E-04 | 1.49E-05 | 6.00E-04 | 5.82E-05 | 3.76E-04 |
| **KRI->DIC** | 8.49E-05 | 7.96E-04 | 8.49E-05 | 7.96E-04 | 8.49E-05 | 7.96E-04 | 5.90E-05 | 3.42E-04 |
| **KRI->DOC** | 2.80E-05 | 5.30E-04 | 2.80E-05 | 5.30E-04 | 2.80E-05 | 5.30E-04 | 1.77E-05 | 2.22E-04 |
| **KRI->GRO** | 0.00E+00 | 4.59E-04 | 0.00E+00 | 4.59E-04 | 0.00E+00 | 4.59E-04 | 0.00E+00 | 6.80E-05 |
| **DET->CIL** | 0.00E+00 | 1.54E-01 | 0.00E+00 | 1.54E-01 | 0.00E+00 | 1.54E-01 | 0.00E+00 | 1.66E-01 |
| **DET->COP** | 0.00E+00 | 1.54E-01 | 0.00E+00 | 1.54E-01 | 0.00E+00 | 1.54E-01 | 0.00E+00 | 1.66E-01 |
| **DET->HNA** | 0.00E+00 | 0.00E+00 | 0.00E+00 | 1.54E-01 | 0.00E+00 | 1.54E-01 | 0.00E+00 | 1.66E-01 |
| **DET->SED** | 0.00E+00 | 1.54E-01 | 0.00E+00 | 1.54E-01 | 0.00E+00 | 1.54E-01 | 0.00E+00 | 1.63E-01 |
| **DET->DOC** | 0.00E+00 | 1.54E-01 | 0.00E+00 | 1.54E-01 | 0.00E+00 | 1.54E-01 | 1.39E-02 | 4.95E-02 |
| **BAC->CIL** | 1.51E-03 | 3.02E-01 | 0.00E+00 | 3.02E-01 | 0.00E+00 | 3.02E-01 | 0.00E+00 | 2.43E+00 |
| **BAC->HNA** | 0.00E+00 | 0.00E+00 | 0.00E+00 | 2.20E+00 | 0.00E+00 | 2.20E+00 | 0.00E+00 | 2.43E+00 |
| **BAC->DIC** | 9.54E-02 | 2.61E+00 | 1.05E-01 | 2.71E+00 | 1.39E-01 | 2.56E+00 | 1.77E+00 | 1.79E+00 |
| **BAC->DOC** | 1.91E-04 | 1.21E-01 | 2.23E-04 | 7.58E-01 | 3.17E-04 | 7.58E-01 | 2.42E-01 | 2.68E-01 |
| **BAC->SED** | 0.00E+00 | 6.05E-03 | 0.00E+00 | 4.32E-02 | 0.00E+00 | 4.32E-02 | 0.00E+00 | 1.52E-02 |
| **DOC->BAC** | 2.14E-01 | 2.75E+00 | 2.50E-01 | 4.42E+00 | 3.47E-01 | 4.42E+00 | 4.43E+00 | 4.48E+00 |
| **CAP->COD** | 0.00E+00 | 7.31E-04 | 0.00E+00 | 7.31E-04 | 0.00E+00 | 7.31E-04 | 0.00E+00 | 0.00E+00 |
| **CAP->YCO** | 0.00E+00 | 7.31E-04 | 0.00E+00 | 7.31E-04 | 0.00E+00 | 7.31E-04 | 0.00E+00 | 0.00E+00 |
| **CAP->DIC** | 1.00E-03 | 1.61E-03 | 1.00E-03 | 1.61E-03 | 1.00E-03 | 1.61E-03 | 0.00E+00 | 0.00E+00 |
| **CAP->DOC** | 0.00E+00 | 6.15E-04 | 0.00E+00 | 6.15E-04 | 0.00E+00 | 6.15E-04 | 0.00E+00 | 0.00E+00 |
| **CAP->DET** | 1.52E-04 | 6.60E-04 | 1.52E-04 | 6.60E-04 | 1.52E-04 | 6.60E-04 | 0.00E+00 | 0.00E+00 |
| **CAP->GRA** | 0.00E+00 | 7.31E-04 | 0.00E+00 | 7.31E-04 | 0.00E+00 | 7.31E-04 | 0.00E+00 | 0.00E+00 |
| **CAP->GRO** | 0.00E+00 | 7.31E-04 | 0.00E+00 | 7.31E-04 | 0.00E+00 | 7.31E-04 | 0.00E+00 | 0.00E+00 |
| **HER->COD** | 2.37E-06 | 6.11E-05 | 2.37E-06 | 6.11E-05 | 2.37E-06 | 6.11E-05 | 2.64E-05 | 4.30E-05 |
| **HER->YCO** | 0.00E+00 | 5.49E-05 | 0.00E+00 | 5.49E-05 | 0.00E+00 | 5.49E-05 | 0.00E+00 | 3.47E-05 |
| **HER->DIC** | 3.63E-04 | 7.88E-04 | 3.63E-04 | 7.88E-04 | 3.63E-04 | 7.88E-04 | 3.64E-04 | 7.88E-04 |
| **HER->DOC** | 2.27E-05 | 2.09E-04 | 2.27E-05 | 2.09E-04 | 2.27E-05 | 2.09E-04 | 2.35E-05 | 2.09E-04 |
| **HER->DET** | 3.63E-05 | 3.34E-04 | 3.63E-05 | 3.34E-04 | 3.63E-05 | 3.34E-04 | 3.75E-05 | 3.34E-04 |
| **HER->GRA** | 0.00E+00 | 5.87E-05 | 0.00E+00 | 5.87E-05 | 0.00E+00 | 5.87E-05 | 0.00E+00 | 3.47E-05 |
| **HER->GRO** | 0.00E+00 | 5.87E-05 | 0.00E+00 | 5.87E-05 | 0.00E+00 | 5.87E-05 | 0.00E+00 | 3.47E-05 |
| **YCO->COD** | 6.18E-06 | 2.40E-04 | 6.18E-06 | 2.40E-04 | 6.18E-06 | 2.40E-04 | 6.87E-05 | 1.50E-04 |
| **YCO->DIC** | 5.83E-05 | 1.33E-03 | 5.83E-05 | 1.33E-03 | 5.83E-05 | 1.33E-03 | 3.14E-05 | 7.18E-04 |
| **YCO->DOC** | 1.74E-05 | 2.13E-04 | 1.74E-05 | 2.13E-04 | 1.74E-05 | 2.13E-04 | 9.37E-06 | 1.15E-04 |
| **YCO->DET** | 5.53E-05 | 5.27E-04 | 5.53E-05 | 5.27E-04 | 5.53E-05 | 5.27E-04 | 2.98E-05 | 2.84E-04 |
| **YCO->GRA** | 0.00E+00 | 8.71E-04 | 0.00E+00 | 8.71E-04 | 0.00E+00 | 8.71E-04 | 0.00E+00 | 4.04E-04 |
| **YCO->GRO** | 0.00E+00 | 8.71E-04 | 0.00E+00 | 8.71E-04 | 0.00E+00 | 8.71E-04 | 0.00E+00 | 4.04E-04 |
| **COD->DIC** | 3.10E-04 | 1.28E-03 | 3.10E-04 | 1.28E-03 | 3.10E-04 | 1.28E-03 | 1.55E-04 | 4.20E-04 |
| **COD->DOC** | 2.41E-05 | 1.84E-04 | 2.41E-05 | 1.84E-04 | 2.41E-05 | 1.84E-04 | 1.20E-05 | 6.00E-05 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **COD->DET** | 7.65E-05 | 4.53E-04 | 7.65E-05 | 4.53E-04 | 7.65E-05 | 4.53E-04 | 3.83E-05 | 1.48E-04 |
| **COD->GRA** | 0.00E+00 | 3.02E-04 | 0.00E+00 | 3.02E-04 | 0.00E+00 | 3.02E-04 | 0.00E+00 | 9.88E-05 |
| **COD->GRO** | 0.00E+00 | 3.02E-04 | 0.00E+00 | 3.02E-04 | 0.00E+00 | 3.02E-04 | 0.00E+00 | 9.88E-05 |

**Supplement 2. Equalities and inequalities for the spring food web model HF0, where A→B denotes a food web flow from A to B (g C $m^{-2}$ $d^{-1}$) and SS_X denotes the standing stock of X (g C $m^{-2}$). Abbreviations as in Fig S1.**

**Phytoplankton**

Net particulate primary production is between 1 and 1.5 gC $m^{-2}$ $d^{-1}$.

DIC→AUT + DIC→DIA + DIC→PHA

- (AUT→DIC + DIA→DIC + PHA→DIC)

- (AUT→DOC + DIA→DOC + PHA→DOC) > 1

DIC→AUT + DIC→DIA + DIC→PHA

- (AUT→DIC + DIA→DIC + PHA→DIC)

- (AUT→DOC + DIA→DOC + PHA→DOC) < 1.5

Sedimentation is between 0.5 and 1.8 gC $m^{-2}$ $d^{-1}$.

AUT→SED + DIA→SED + PHA→SED > 0.5

AUT→SED + DIA→SED + PHA→SED < 1.8

Respiration is between 5 and 30% of the gross primary production

PHA→DIC > 0.05 · DIC→PHA

PHA→DIC < 0.3 · DIC→PHA

DIA→DIC > 0.05 · DIC→DIA

DIA→DIC < 0.3 · DIC→DIA

AUT→DIC > 0.05 · DIC→AUT

AUT→DIC < 0.3 · DIC→AUT

Excretion is between 5 and 60% of the net primary production

PHA→DOC > 0.05 · (DIC→PHA - PHA→DIC)

PHA→DOC < 0.6 · (DIC→PHA - PHA→DIC)

DIA→DOC > 0.05 · (DIC→DIA - DIA→DIC)

DIA→DOC < 0.6 · (DIC→DIA - DIA→DIC)

AUT→DOC > 0.05 · (DIC→AUT - AUT→DIC)

AUT→DOC < 0.6 · (DIC→AUT - AUT→DIC)

Sedimentation is between 0.6 and 0.8 gC $m^{-2}$ $d^{-1}$ for *Phaeocystis sp.*, between 0.05 and 0.15 gC $m^{-2}$ $d^{-1}$ for diatoms and between 0.5 and 1.8 for phytoplankton in total

PHA→SED > 0.6

PHA→SED < 0.8

DIA→SED > 0.05

DIA→SED < 0.15

PHA→SED + DIA→SED + AUT→SED > 0.5

PHA→SED + DIA→SED + AUT→SED < 1.8

Net primary production is between 0.5 and 1.5 $d^{-1}$

DIC→PHA - PHA→DIC > 0.5 · SS_PHA

DIC→PHA - PHA→DIC < 1.5 · SS_PHA

DIC→DIA - DIA→DIC > 0.5 · SS_DIA

DIC→DIA - DIA→DIC < 1.5 · SS_DIA

DIC→AUT - AUT→DIC > 0.5 · SS_AUT

DIC→AUT - AUT→DIC < 1.5 · SS_AUT

**Protozoa**

Respiration is higher than 0.08 $d^{-1}$

CIL→DIC > 0.08 · SS_CIL

HNA→DIC > 0.08 · SS_HNA

Excretion is between 33 and 100% of respiration

CIL→DOC > 0.33 · CIL→DIC

CIL→DOC < 1 · CIL→DIC

$HNA \rightarrow DOC > 0.33 \cdot HNA \rightarrow DIC$

$HNA \rightarrow DOC < 1 \cdot HNA \rightarrow DIC$

Ingestion is smaller than 7 $d^{-1}$

$BAC \rightarrow CIL + DET \rightarrow CIL + DIA \rightarrow CIL + PHA \rightarrow CIL + HNA \rightarrow CIL + AUT \rightarrow CIL < 7 \cdot SS\_CIL$

$DET \rightarrow HNA + PHA \rightarrow HNA + DIA \rightarrow HNA + AUT \rightarrow HNA + BAC \rightarrow HNA < 7 \cdot SS\_CIL$

Gross growth efficiency is between 0.1 and 0.6

$CIL \rightarrow COP > 0.1 \cdot (BAC \rightarrow CIL + DET \rightarrow CIL + DIA \rightarrow CIL + PHA \rightarrow CIL + HNA \rightarrow CIL + AUT \rightarrow CIL)$

$CIL \rightarrow COP < 0.6 \cdot (BAC \rightarrow CIL + DET \rightarrow CIL + DIA \rightarrow CIL + PHA \rightarrow CIL + HNA \rightarrow CIL + AUT \rightarrow CIL)$

$HNA \rightarrow COP + HNA \rightarrow CIL > 0.1 \cdot (DET \rightarrow HNA + PHA \rightarrow HNA + DIA \rightarrow HNA + AUT \rightarrow HNA + BAC \rightarrow HNA)$

$HNA \rightarrow COP + HNA \rightarrow CIL < 0.6 \cdot (DET \rightarrow HNA + PHA \rightarrow HNA + DIA \rightarrow HNA + AUT \rightarrow HNA + BAC \rightarrow HNA)$

**Copepods**

Ingestion is between 0.008 and 0.14 $d^{-1}$

$DET \rightarrow COP + DIA \rightarrow COP + PHA \rightarrow COP + AUT \rightarrow COP + HNA \rightarrow COP + CIL \rightarrow COP > 0.008 \cdot SS\_COP$

$DET \rightarrow COP + DIA \rightarrow COP + PHA \rightarrow COP + AUT \rightarrow COP + HNA \rightarrow COP + CIL \rightarrow COP < 0.14 \cdot SS\_COP$

Respiration is between 0.015 and 0.038 $d^{-1}$

$COP \rightarrow DIC > 0.015 \cdot SS\_COP$

$COP \rightarrow DIC < 0.038 \cdot SS\_COP$

Assimilation efficiency is between 0.5 and 0.9

$DET \rightarrow COP + DIA \rightarrow COP + PHA \rightarrow COP + AUT \rightarrow COP + HNA \rightarrow COP + CIL \rightarrow COP - COP \rightarrow DET > 0.5 \cdot DET \rightarrow COP + DIA \rightarrow COP + PHA \rightarrow COP + AUT \rightarrow COP + HNA \rightarrow COP + CIL \rightarrow COP$

DET→COP + DIA→COP + PHA→COP + AUT→COP + HNA→COP + CIL→COP - COP→DET < 0.9 · DET→COP + DIA→COP + PHA→COP + AUT→COP + HNA→COP + CIL→COP

Gross growth efficiency is lower than 0.4

COP→CHA + COP→CAP + COP→HER + COP→YCO + COP→GRO < 0.1 · DET→COP + DIA→COP + PHA→COP + AUT→COP + HNA→COP + CIL→COP

Excretion is between 33 and 100% of respiration

COP→DOC > 0.33 · COP→DIC

COP→DOC < 1 · COP→DIC

Advection of copepod biomass is smaller than 0.23 gC $m^{-2}$ $d^{-1}$

ATL→COP < 0.23

**Krill**

Ingestion is below 0.4 $d^{-1}$

DIA→KRI + PHA→KRI + AUT→KRI < 0.4 · SS_KRI

Respiration is higher than 0.03 $d^{-1}$

KRI→DIC > 0.03 · SS_KRI

Gross growth efficiency is below 0.4

KRI→CAP + KRI→COD + KRI→HER + KRI→YCO + KRI→CHA + KRI→GRO < 0.4 · DIA→KRI + PHA→KRI + AUT→KRI

Production over biomass ratio is higher than 0.0058 $d^{-1}$

KRI→CAP + KRI→COD + KRI→HER + KRI→YCO + KRI→CHA + KRI→GRO > 0.0058 · SS_KRI

Excretion is between 33 and 100% of respiration

KRI→DOC > 0.33 · KRI→DIC

KRI→DOC < 1 · KRI→DIC

Assimilation efficiency is between 0.5 and 0.9

DIA→KRI + PHA→KRI + AUT→KRI - KRI→DET > 0.5 · DIA→KRI + PHA→KRI + AUT→KRI

DIA→KRI + PHA→KRI + AUT→KRI - KRI→DET < 0.9 · DIA→KRI + PHA→KRI + AUT→KRI

**Chaetognaths**

Ingestion is between 0.1 and 0.3 $d^{-1}$

COP→CHA + KRI→CHA > 0.1 · SS_CHA

COP→CHA + KRI→CHA < 0.3 · SS_CHA

Net growth efficiency is between 0.15 and 0.35

CHA→CAP + CHA→HER + CHA→GRO > 0.15 · COP→CHA + KRI→CHA - 0.35 · CHA→DET

CHA→CAP + CHA→HER + CHA→GRO < 0.35 · COP→CHA + KRI→CHA - 0.15 · CHA→DET

Assimilation efficiency is between 0.7 and 0.9

COP→CHA + KRI→CHA - CHA→DET > 0.7 · COP→CHA + KRI→CHA

COP→CHA + KRI→CHA - CHA→DET < 0.9 · COP→CHA + KRI→CHA

Excretion is between 33 and 100% of respiration

CHA→DOC > 0.33 · CHA→DIC

CHA→DOC < 1 · CHA→DIC

Respiration is between 0.0072 - 0.0252 $d^{-1}$

CHA→DIC > 0.0072 · SS_CHA

CHA→DIC< 0.0252 · SS_CHA

**Detritus**

Dissolution is lower than 0.02 $d^{-1}$

$DET \rightarrow DOC < 0.02 \cdot SS\_DET$

**Bacteria**

Gross growth efficiency is between 0.01 and 0.6

$BAC \rightarrow DIC > DOC \rightarrow BAC - 0.6 \cdot DOC \rightarrow BAC$

$BAC \rightarrow DIC < DOC \rightarrow BAC - 0.01 \cdot DOC \rightarrow BAC$

Sedimentation is below 2% of bacterial production per day

$BAC \rightarrow SED < 0.02 \cdot (BAC \rightarrow CIL + BAC \rightarrow HNA)$

viral feedback rate is 10 to 40% of bacterial production rate

$BAC \rightarrow DOC > 0.1 \cdot (BAC \rightarrow CIL + BAC \rightarrow HNA)$

**All zooplankton**

Fecal pellet production rate is higher than 0.11 gC $m^{-2}$ $d^{-1}$

$COP \rightarrow DET + CHA \rightarrow DET + KRI \rightarrow DET > 0.11$

**Particulate organic carbon**

Sedimentation is between 0.8 and 1.7 gC $m^{-2}$ $d^{-1}$

$PHA \rightarrow SED + DIA \rightarrow SED + AUT \rightarrow SED + DET \rightarrow SED + BAC \rightarrow SED > 0.8$

$PHA \rightarrow SED + DIA \rightarrow SED + AUT \rightarrow SED + DET \rightarrow SED + BAC \rightarrow SED < 1.7$

**Capelin**

Ingestion is between 0.013 and 0.022 $d^{-1}$

$COP \rightarrow CAP + KRI \rightarrow CAP + CHA \rightarrow CAP > 0.013 \cdot SS\_CAP$

$COP \rightarrow CAP + KRI \rightarrow CAP + CHA \rightarrow CAP < 0.022 \cdot SS\_CAP$

Production over biomass is between 0.0036 and 0.0073 $d^{-1}$

$CAP \rightarrow GRA + CAP \rightarrow YCO + CAP \rightarrow COD + CAP \rightarrow GRO > 0.0036 \cdot SS\_CAP$

$CAP \rightarrow GRA + CAP \rightarrow YCO + CAP \rightarrow COD + CAP \rightarrow GRO < 0.0073 \cdot SS\_CAP$

Assimilation efficiency is between 0.7 and 0.9

$COP \rightarrow CAP + KRI \rightarrow CAP + CHA \rightarrow CAP - CAPEgest > 0.7 \cdot COP \rightarrow CAP + KRI \rightarrow CAP + CHA \rightarrow CAP$

$COP \rightarrow CAP + KRI \rightarrow CAP + CHA \rightarrow CAP - CAPEgest < 0.9 \cdot COP \rightarrow CAP + KRI \rightarrow CAP + CHA \rightarrow CAP$

Respiration is between 0.01 and 0.04 $d^{-1}$

$CAP \rightarrow DIC > 0.01 \cdot SS\_CAP$

$CAP \rightarrow DIC < 0.04 \cdot SS\_CAP$

**Herring**

Ingestion is between 0.01 and 0.1 $d^{-1}$

$CHA \rightarrow HER + COP \rightarrow HER + KRI \rightarrow HER > 0.01 \cdot SS\_HER$

$CHA \rightarrow HER + COP \rightarrow HER + KRI \rightarrow HER < 0.1 \cdot SS\_HER$

Maintenance respiration is between 0.019 and 0.024 $d^{-1}$; growth respiration is between 0.0875 - 0.263 $d^{-1}$

$HER \rightarrow DIC > 0.019 \cdot SS\_HER + 0.0875 \cdot CHA \rightarrow HER + COP \rightarrow HER + KRI \rightarrow HER - 0.263 \cdot HER \rightarrow DET$

$HER \rightarrow DIC < 0.024 \cdot SS\_HER + 0.263 \cdot CHA \rightarrow HER + COP \rightarrow HER + KRI \rightarrow HER - 0.0875 \cdot HER \rightarrow DET$

Assimilation efficiency is between 0.76 and 0.92

$CHA \rightarrow HER + COP \rightarrow HER + KRI \rightarrow HER - CAP \rightarrow DET > 0.76 \cdot COP \rightarrow CAP + KRI \rightarrow CAP + CHA \rightarrow CAP$

$CHA \rightarrow HER + COP \rightarrow HER + KRI \rightarrow HER - CAP \rightarrow DET < 0.92 \cdot COP \rightarrow CAP + KRI \rightarrow CAP + CHA \rightarrow CAP$

Excretion is between 0.05 and 0.15 of the ingestion

$HER \rightarrow DOC > 0.05 \cdot CHA \rightarrow HER + COP \rightarrow HER + KRI \rightarrow HER - CAP \rightarrow DET$

$HER \rightarrow DOC < 0.15 \cdot CHA \rightarrow HER + COP \rightarrow HER + KRI \rightarrow HER - CAP \rightarrow DET$

**Adult cod**

Ingestion is between 0.017 and 0.054 $d^{-1}$

$CAP \rightarrow COD + KRI \rightarrow COD + HER \rightarrow COD + YCO \rightarrow COD > 0.017 \cdot SS\_COD$

$CAP \rightarrow COD + KRI \rightarrow COD + HER \rightarrow COD + YCO \rightarrow COD < 0.054 \cdot SS\_COD$

Gross growth efficiency is between 0.2 and 0.5

$COD\text{->}GRA + COD\text{->}GRO > 0.2 \cdot CODUptake$

$COD\text{->}GRA + COD\text{->}GRO < 0.5 \cdot CODUptake$

Assimilation efficiency is between 0.7 and 0.9

$CAP \rightarrow COD + KRI \rightarrow COD + HER \rightarrow COD + YCO \rightarrow COD - COD \rightarrow DET > 0.7 \cdot CAP \rightarrow COD + KRI \rightarrow COD + HER \rightarrow COD + YCO \rightarrow COD$

$CAP \rightarrow COD + KRI \rightarrow COD + HER \rightarrow COD + YCO \rightarrow COD - COD \rightarrow DET < 0.9 \cdot CAP \rightarrow COD + KRI \rightarrow COD + HER \rightarrow COD + YCO \rightarrow COD$

Excretion is between 0.045 and 0.135 of assimilation

$COD \rightarrow DOC > 0.045 \cdot (CAP \rightarrow COD + KRI \rightarrow COD + HER \rightarrow COD + YCO \rightarrow COD - COD \rightarrow DET)$

$COD \rightarrow DOC < 0.135 \cdot (CAP \rightarrow COD + KRI \rightarrow COD + HER \rightarrow COD + YCO \rightarrow COD - COD \rightarrow DET)$

Krill ingestion by cod is 7 to 9 times herring ingestion by cod

$KRI \rightarrow COD > 7 \cdot HER \rightarrow COD$

$KRI \rightarrow COD < 9 \cdot HER \rightarrow COD$

Krill ingestion by cod is 2 to 4 times young cod ingestion by cod

$KRI \rightarrow COD > 2 \cdot YCO \rightarrow COD$

KRI→COD < 4 · YCO→COD

**Young cod**

Ingestion is between 0.017 and 0.054 $d^{-1}$

COP→YCO + KRI→YCO + HER→YCO + CAP→YCO > 0.017 · SS_YCO

COP→YCO + KRI→YCO + HER→YCO + CAP→YCO < 0.054 · SS_YCO

Gross growth efficiency is between 0.2 and 0.5

YCO→COD + YCO→GRA + YCO→GRO > 0.2 · COP→YCO + KRI→YCO + HER→YCO + CAP→YCO

YCO→COD + YCO→GRA + YCO→GRO < 0.5 · COP→YCO + KRI→YCO + HER→YCO + CAP→YCO

Assimilation efficiency is between 0.7 and 0.9

COP→YCO + KRI→YCO + HER→YCO + CAP→YCO - YCO→DET > 0.7 · COP→YCO + KRI→YCO + HER→YCO + CAP→YCO

COP→YCO + KRI→YCO + HER→YCO + CAP→YCO - YCO→DET < 0.9 · COP→YCO + KRI→YCO + HER→YCO + CAP→YCO

Excretion is between 0.045 and 0.135 of assimilation

YCO→DOC > 0.045 · (COP→YCO + KRI→YCO + HER→YCO + CAP→YCO - YCO→DET)

YCO →DOC < 0.135 · (COP→YCO + KRI→YCO + HER→YCO + CAP→YCO - YCO→DET)

Feeding on herring is less important than feeding on copepods, krill or capelin

HER→YCO < COP→YCO

HER→YCO < KRI→YCO

HER→YCO < CAP→YCO