Supplementary Materials for Marine carbon cycling and sequestration is extremely sensitive to zooplankton grazing in biogeochemical models

Tyler Rohr,[1*] Anthony J. Richardson,[2,3] Andrew Lenton,[4]
Matthew A. Chamberlain,[4] Elizabeth Shadwick[1,4]

*To whom correspondence should be addressed; E-mail: tyler.rohr@csiro.au.

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Supplemental Figures S1-S5

Supplemental Tables S1

1 Supplemental Figures

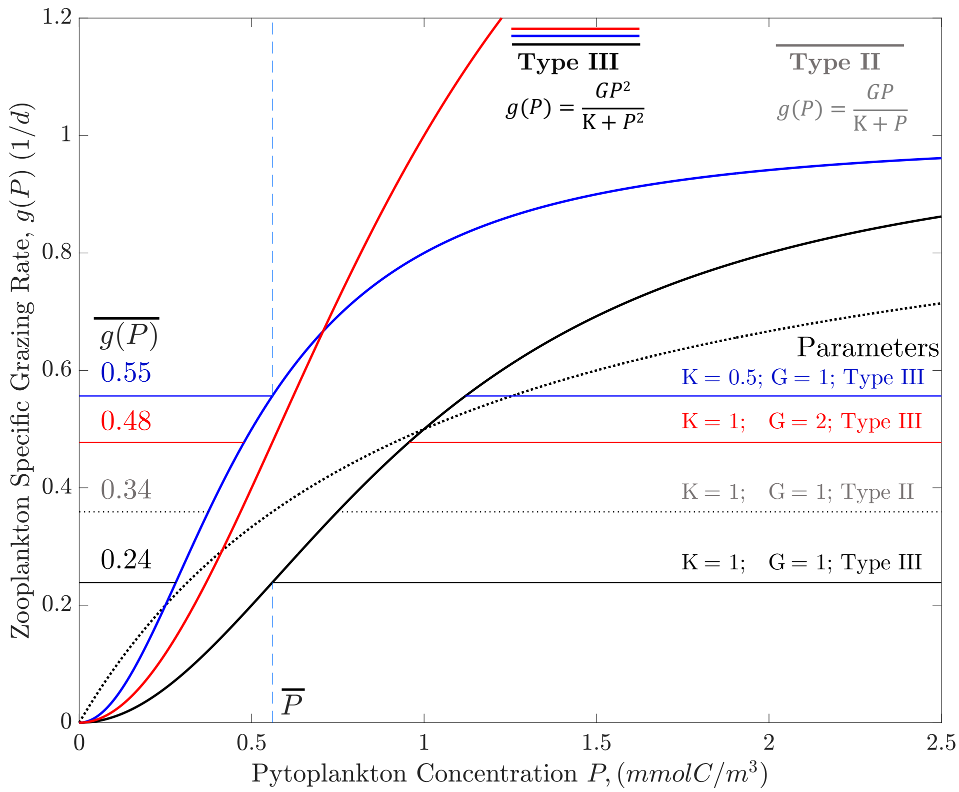

Figure S1: Schematic of the functional response curve and *Grazing Pressure* diagnostic. A type III single-prey response curve, parameterized with $K = 1$ and $G = 1$ is shown in black along with it's associated *Grazing Pressure*, calculated at $\overline{P} = 0.56$, the global, mean annual phytoplankton concentration across all simulations in the standard experiment suite (Table S1). It is then shown how the response curve, and its associated *Grazing Pressure*, is modified by halving K (blue), doubling G (red), or switching to a type II response (grey). In all cases, *Grazing Pressure* increases.

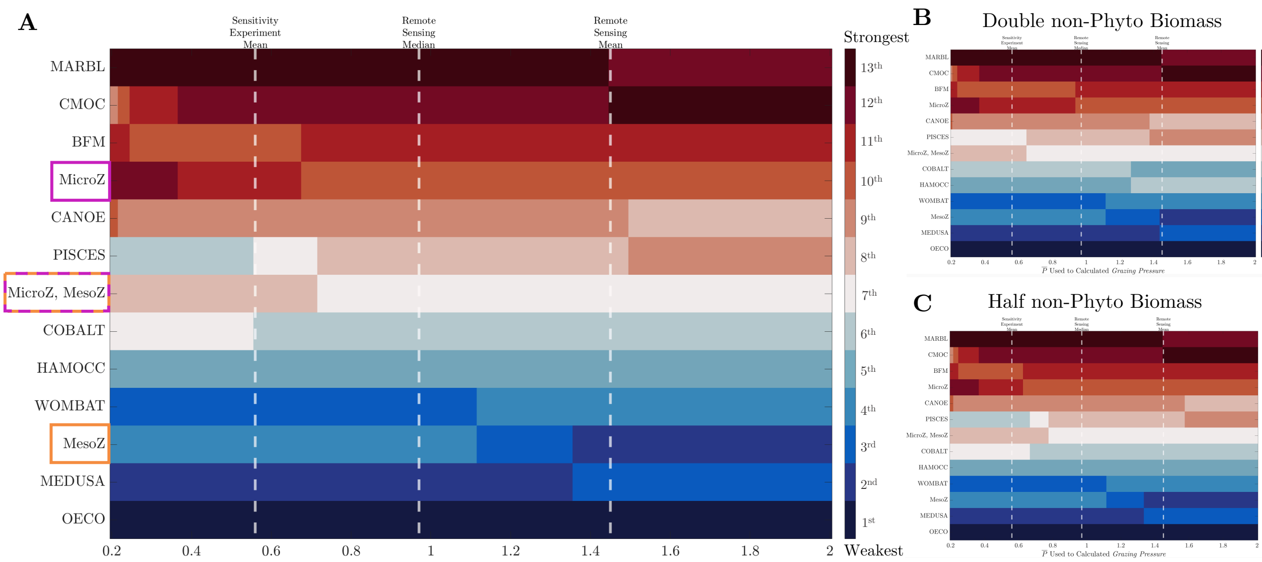

Figure S2: Sensitivity of *Grazing Pressure* to the selection of $\overline{P}$. *Grazing Pressure* was computed using a range of values for $\overline{P}$, including the global mean value averaged across our experiments as well as the global mean and median values from the remote sensing record. We then sorted the full set of model approximation and empirical estimates from weakest to strongest *Grazing Pressure*. The order in that hierarchy is plotted against the assumed $\overline{P}$ value, from dark blue (1^{st}) being the weakest and dark red (13^{th}) being the strongest. In panel **A**. each non-phytoplankton biomass type (i.e. bacteria, detritus/POC, and zooplankton) was assumed equal to phytoplankton biomass. In panel **B**. and **C**. non-phytoplankton biomass was doubled and halved, respectively. The order of each model is generally consistent (i.e. a similar color moving left to right), regardless of assumptions about $\overline{P}$ or non-phytoplankton biomass, implying that *Grazing Pressure* is a robust metric with which to compare differences in assumed grazing rates between models. In other words, the relative rate of grazing (between models) is not overly sensitive to standardized mean prey abundance.

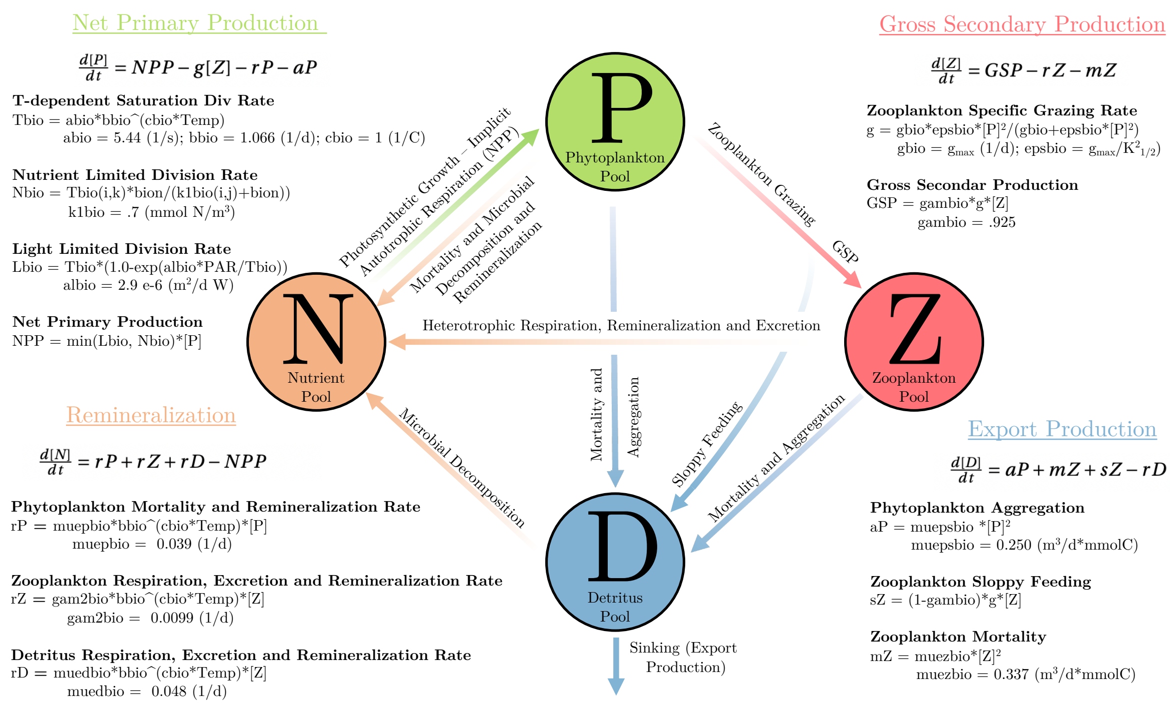

Figure S3: Partial schematic of the control WOMBAT BGC model configuration. Only includes Nutrient (N), Phytoplankton (P), Zooplankton (Z), Detirtius (D) state variables.

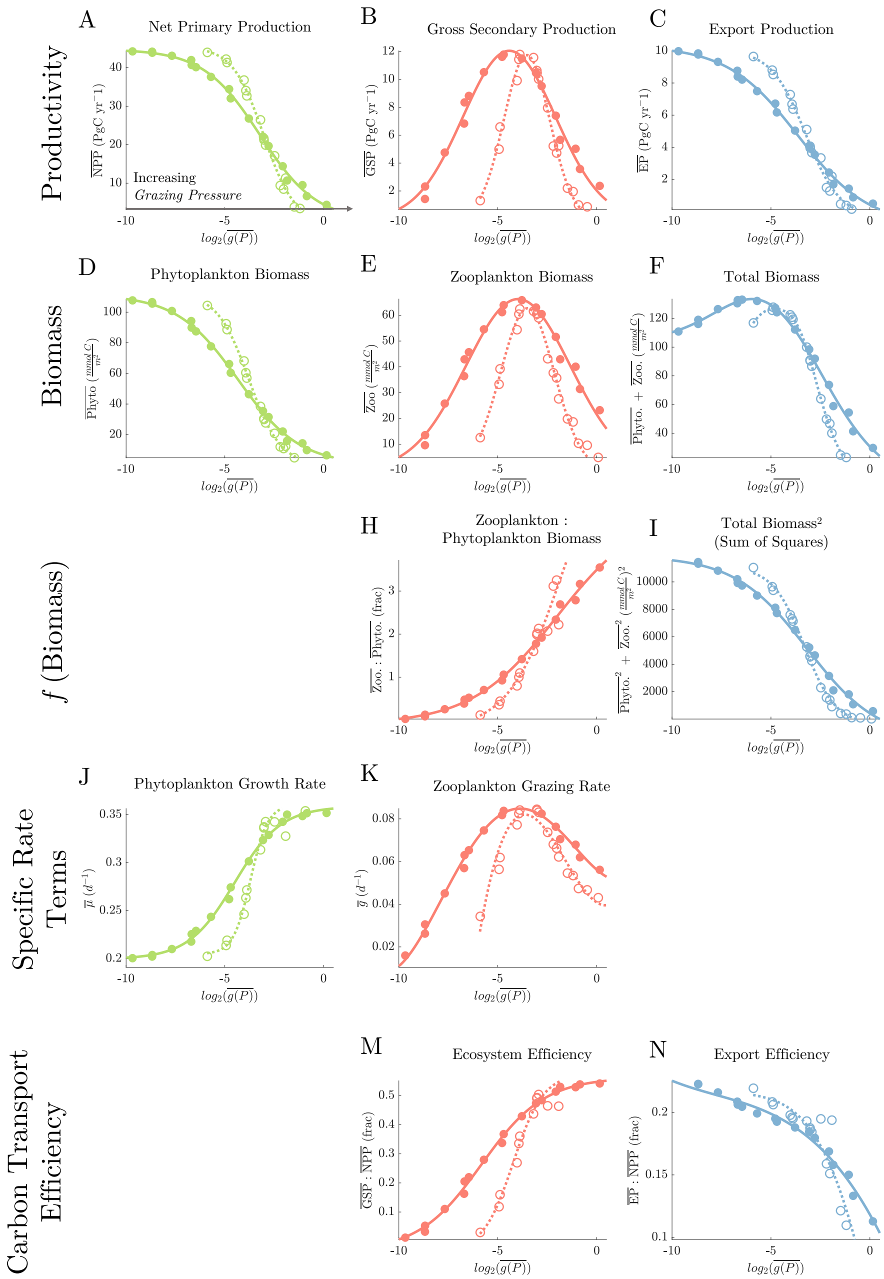

Figure S4: Sensitivity of marine biogeochemistry to *Grazing Pressure*. Globally averaged, mean-annual model output for simulations using a type III (solid line) and type II (dashed line) are plotted against their prescribed *Grazing Pressure*. The format is identical to Fig. 1 (in Main Text), except additional variables and the suite of Type II experiments are included.

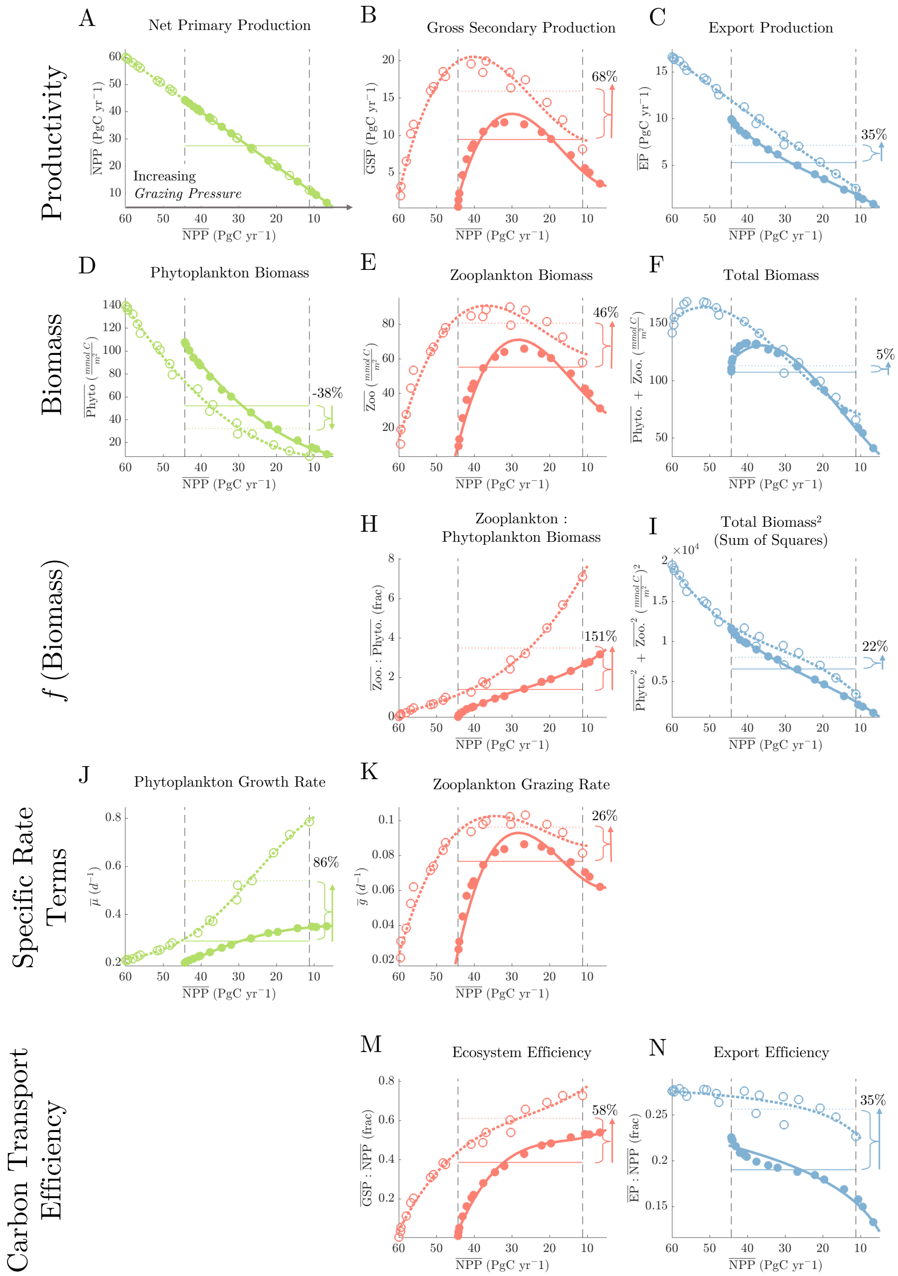

Figure S5: Sensitivity of marine biogeochemistry to model tuning. Identical to Fig. 2 (in Main Text), but for additional model output (same as shown in Fig. S4). Horizontal lines have been added to show the mean value, averaged across the 'Fast' (dashed) and 'Standard' (solid) ensembles. Ensemble averages are computed between dashed vertical lines on the curves fit to each set of experimental data.

2 Supplemental Tables

Experiment Suite	Control (WOMBAT)	Standard	Type II	Fast
Zooplankton Functional Response	Type III	Type III	Type II	Type III
Phytoplankton Saturation Growth Rate at 16°C μ_{max} (d^{-1})	0.75	0.75	0.75	2.38 (MARBL)
Zooplankton-specific Saturation Grazing Rate g_{max} (d^{-1})	1.575	[.5,1,2]	[.5,1,2]	[.5,1,2]
Half-Saturation Concentration $K_{1/2}$ ($\frac{mmolC}{m^3}$)	6.57	[.5,1,2,4,8,16]	[.5,1,2,4,8,16]	[.5,1,2,4,8,16]

Table S1: Description of model runs. The functional response type and parameterization of each experiment suite and control run are indicated. All other aspects of the BGC model configuration and parameterization are identical to the standard configuration of WOMBAT.