

1. Model-data comparison

The Bayesian Monte Carlo approach was not performed for the updated model with Fe limitation that we use in this study. Instead, we took the 31 combinations of selected parameters from the Monte Carlo approach on the standard version of the model performed in Bianchi et al. (2021), and run 31 simulations with the updated Fe-limited version of the model. The Fe limitation decreases global fish biomass slightly (Galbraith et al., 2019) so that we underestimate the global LME peak catch of $110\text{Mt} \cdot \text{yr}^{-1}$ (Fig. S1). The comparison of modeled versus observed peak catch across LMEs gives an r^2 of 0.42 (p-value $< 10^{-9}$) for the ensemble average, while the ensemble member with the best fit to observations has an r^2 of 0.57 (p-value $< 10^{-9}$) (Fig. S2) (Bianchi et al., 2021).

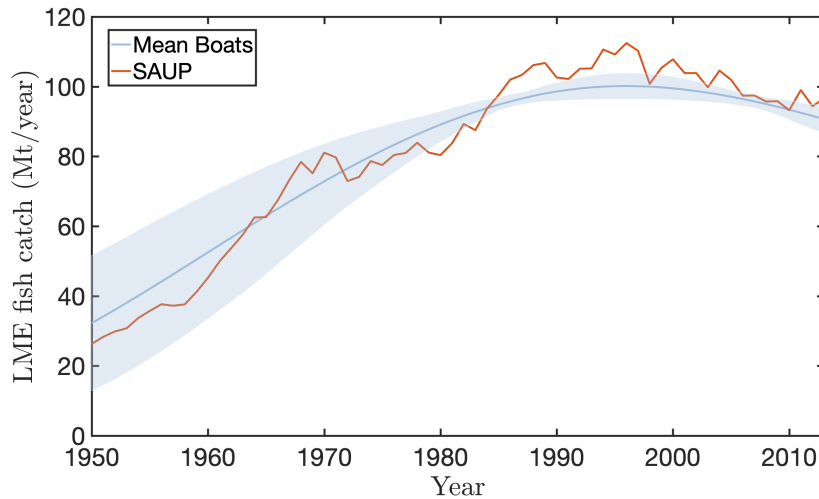


Figure S1: Modeled fish catch from the 31 simulations of the ensemble from 1950 to 2010s compared to SAUP reconstructed catch data.

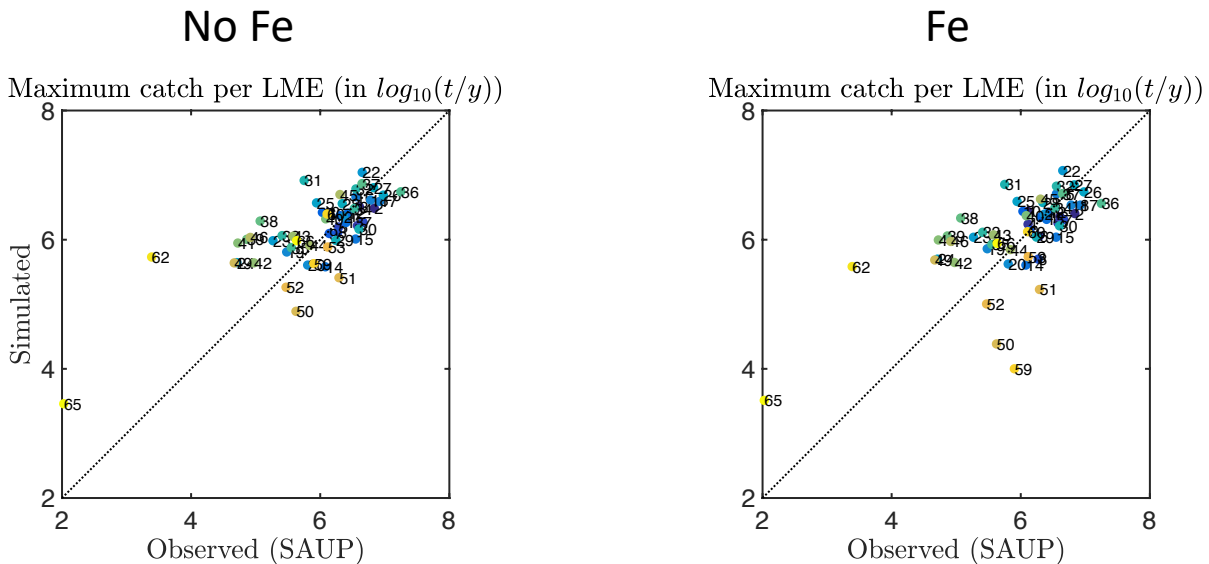


Figure S2: Comparison between LMEs maximum catch from data and from the model ensemble in the ensemble of simulations with no Fe limitation and in the ensemble of simulations with Fe limitation. Each number represents one LME.

2. Global values and nutrient inputs to the ocean

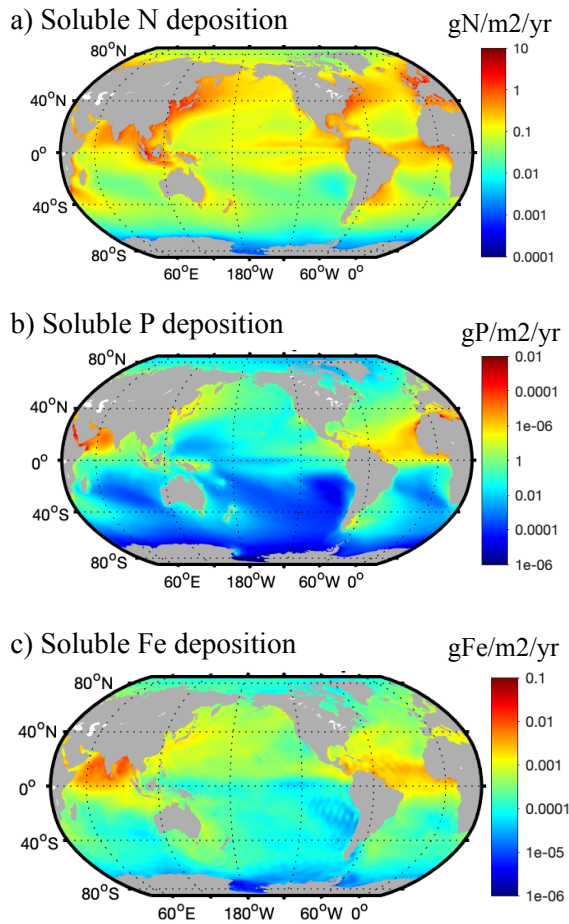
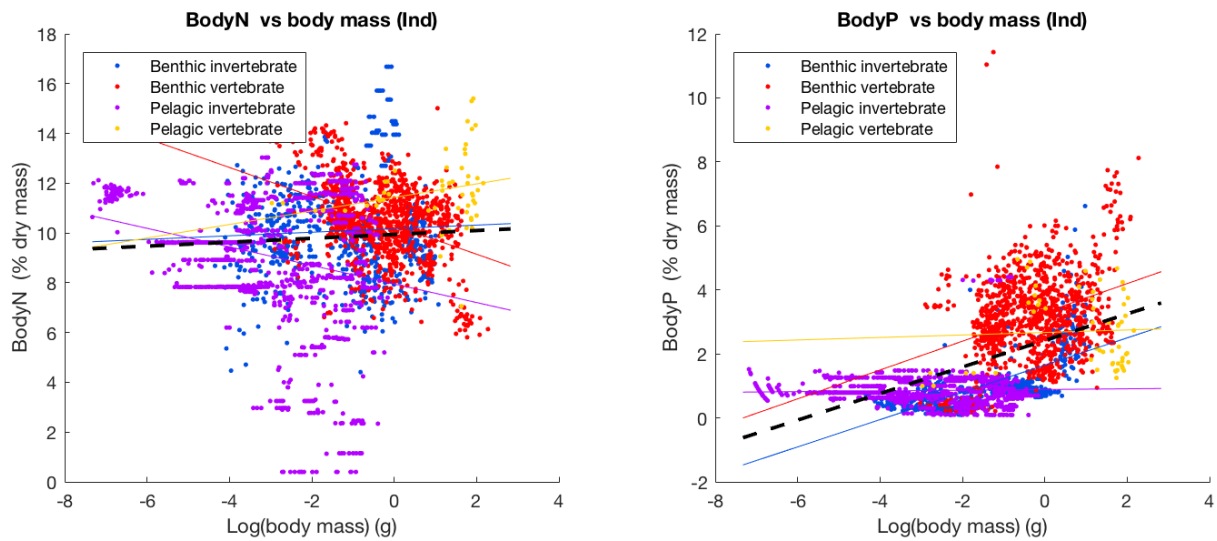


Figure S3: Modeled deposition fields of soluble a) N (gN/m²/yr), b) P (gP/m²/yr) and c) Fe (gFe/m²/yr) used to make Figure 8. N and P fields are from Brahney et al. (2015), Fe field is from Mahowald et al. (2009).

Table S1: Inputs of nutrients to the ocean.

Sources (Tg/yr)	N	P	Fe	Reference	Comment
Atmospheric deposition	63	0.32	0.36	Okin et al. (2011)	
	-	0.17	-	Myriokefalitakis et al. (2016)	bioavailable P
	29.4	-	-	Fowler et al. (2013)	
	-	-	13.4	Ito (2015)	
	-	-	8.4	Wang et al. (2015)	With Anthropogenic input
	50	-	-	Gruber and Galloway (2008)	NO_3^- and NH_4^+
	-	0.31	-	Benitez-Nelson (2000)	pre-anthropogenic, soluble reactive P
	16 (6.4)	0.35 (0.02)	-	Kanakidou et al. (2012)	organic soluble (anthropogenic contribution)
	36.6	-	-	Kanakidou et al. (2012)	Total inorganic N
	-	0.24 (0.034)	-	Mahowald et al. (2009)	Inorganic P (anthropogenic contribution)
	-	-	0.6-2	Moreno and Haffa (2014)	
Rivers	-	0.93-4.7	-	Benitez-Nelson (2000)	pre-anthropogenic
	-	23-48	-	Benitez-Nelson (2000)	Total with anthropogenic
	80	-	-	Gruber and Galloway (2008)	
	-	-	0.08-0.09	Moreno and Haffa (2014)	
N ₂ fixation	140	-	-	Gruber and Galloway (2008)	
Iceberg melting	-	-	0.09-0.1	Moreno and Haffa (2014)	

3. Body nutrient content versus body size



	Nitrogen				Phosphorus			
	Intercept	Slope	R	p-value	Intercept	Slope	R	p-value
All	9.9	0.08	0.07	4.3e-5**	2.4	0.42	0.58	3.4e-299**
Invertebrate								
All	9.3	-0.07	-0.05	0.0138*	1.3	0.12	0.34	4.2e-63**
Pelagic	8.0	-0.37	-0.25	6.1e-24**	0.9	0.01	0.04	0.113
Benthic	10.2	0.07	0.05	0.207	1.7	0.43	0.66	3.3e-87**
Vertebrate								
All	10.4	-0.41	-0.29	2e-21**	3.2	0.37	0.29	8.4e-22**
Pelagic	11.4	0.27	0.26	0.058	2.7	0.04	0.05	0.74
Benthic	10.3	-0.58	-0.39	3.6e-37**	3.3	0.45	0.34	4.0e-28**

Figure S4: Body N (% of dry weight) and body P (% of dry weight), as a function of body mass (log(g)) for pelagic (purple) and benthic (blue) invertebrates and for pelagic (orange) and benthic (red) vertebrates. Regression lines for each type of organisms are shown in the same color. The dashed black line is the global regression line. Regression coefficients are given in the underneath table. Data from Vanni et al. (2017).

4. Cycling of N and P, Fe cycling computations versus PP demand for Fe

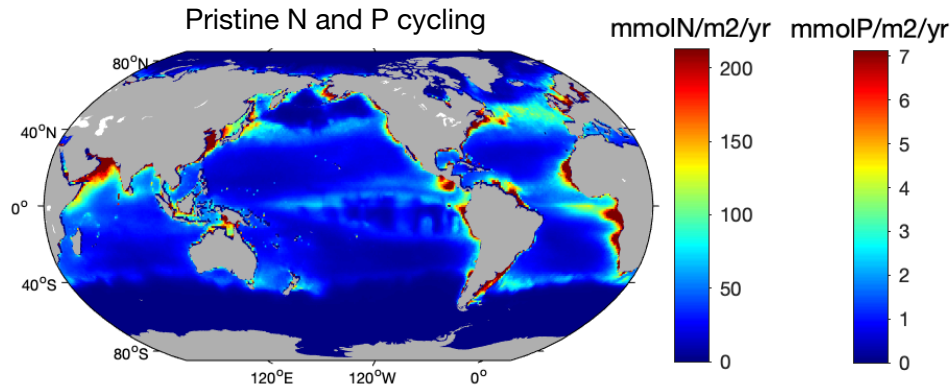


Figure S5: N and P cycling prior to industrial fishing.

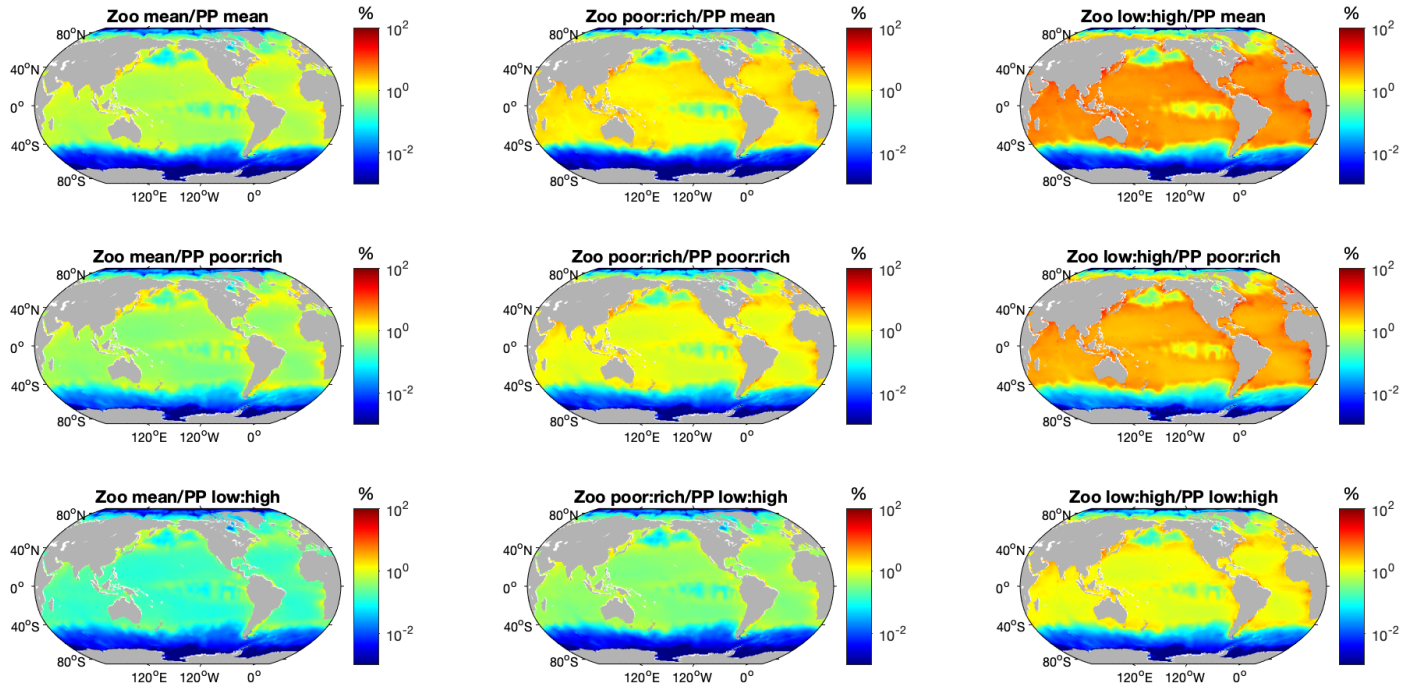


Figure S6: Fish Fe cycling relative to phytoplankton demand for Fe.

The columns distinguish between three computations of the Fe cycling by fish: *left* = using a mean Fe:C in zooplankton, *middle* = using a spatial interpolation between the zooplankton mean Fe:C in Fe-rich and in Fe-poor conditions, *right* = using a spatial interpolation between the zooplankton low Fe:C and high Fe:C estimates. The rows distinguish between three computations of the phytoplankton Fe demand: *top* = using a mean Fe:C in phytoplankton, *middle* = using a spatial interpolation between the mean phytoplankton Fe:C values in Fe-rich and Fe-poor conditions, *bottom* = using a spatial interpolation between low and high phytoplankton Fe:C estimates (Table 1). Spatial interpolations are based on nitrate concentrations as a proxy for Fe concentrations (HNLC vs. non-HNLC areas).

5. Size-spectrum of abundance, biomass and C cycling

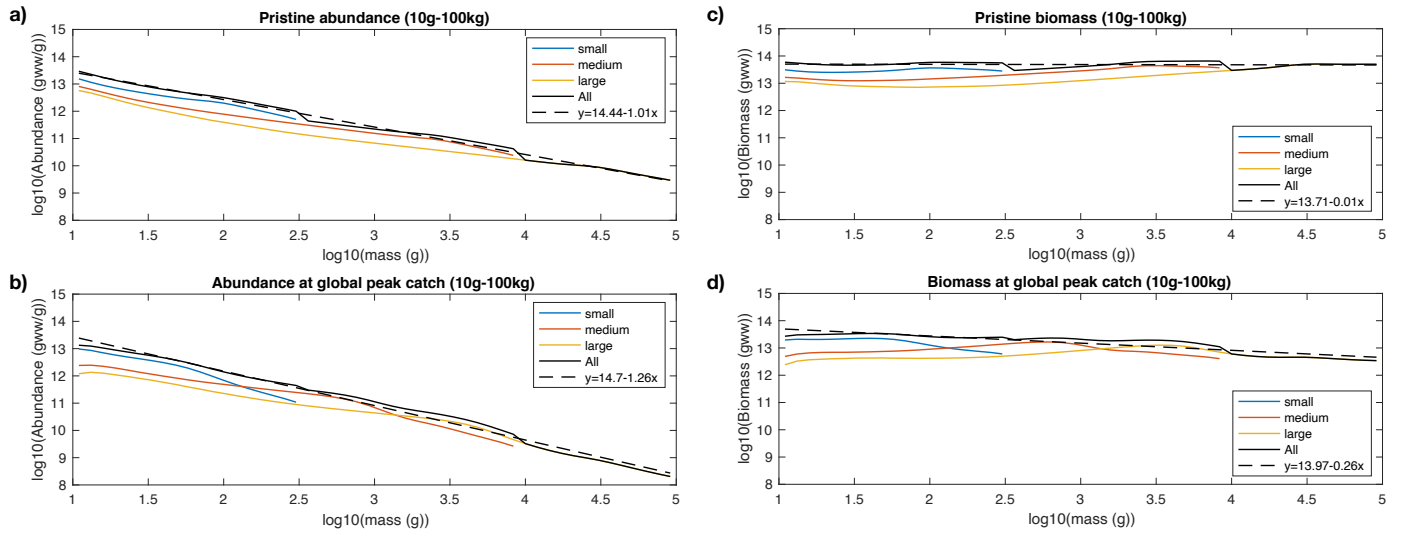


Figure S7: Size-spectrum of modeled CTF^{100kg}_{10g} abundance a) in the pristine state and b) at global peak catch, and size-spectrum of modeled CTF^{100kg}_{10g} biomass c) in the pristine state and d) at global peak catch.

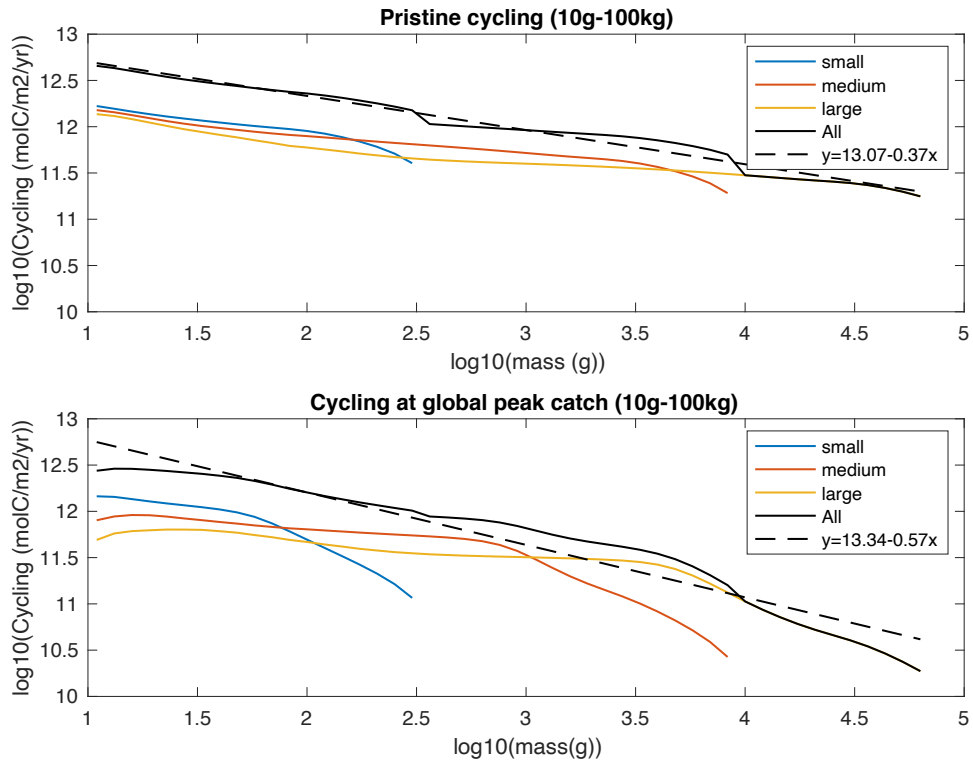


Figure S8: Size spectrum of modeled CTF^{100kg}_{10g} C cycling a) in the pristine state and b) at global peak catch.

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