Revised figures and tables

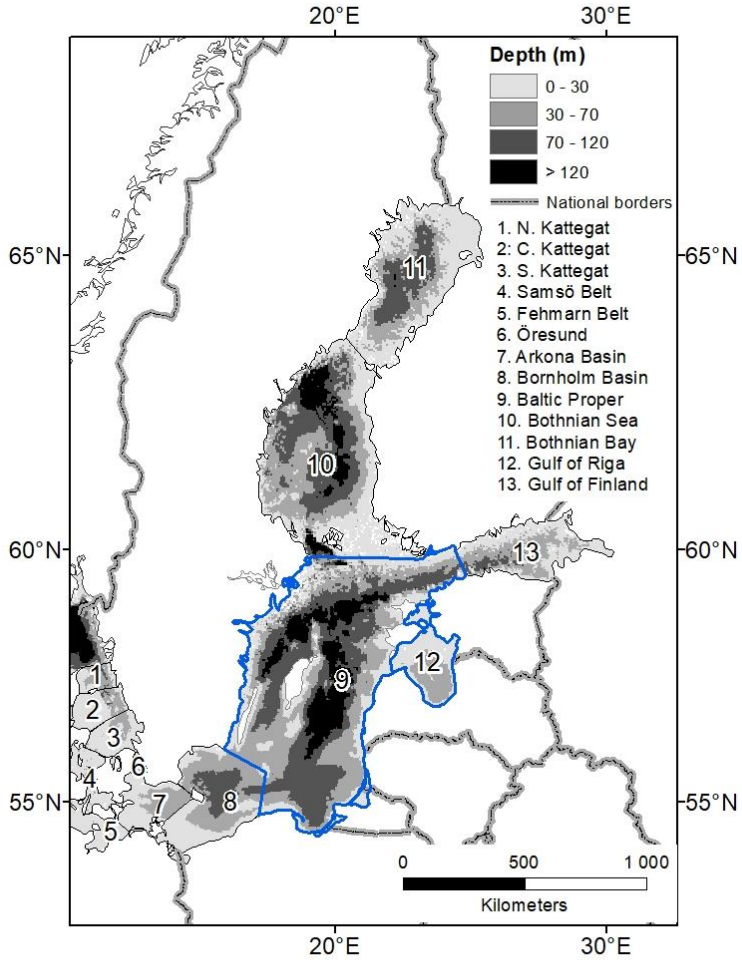

Figure 1. The Baltic Sea hypsography and basin divisions in the BALTSEM model. This study focusses on the Baltic Proper (basin 9) and Gulf of Riga (basin 12), outlined in blue.

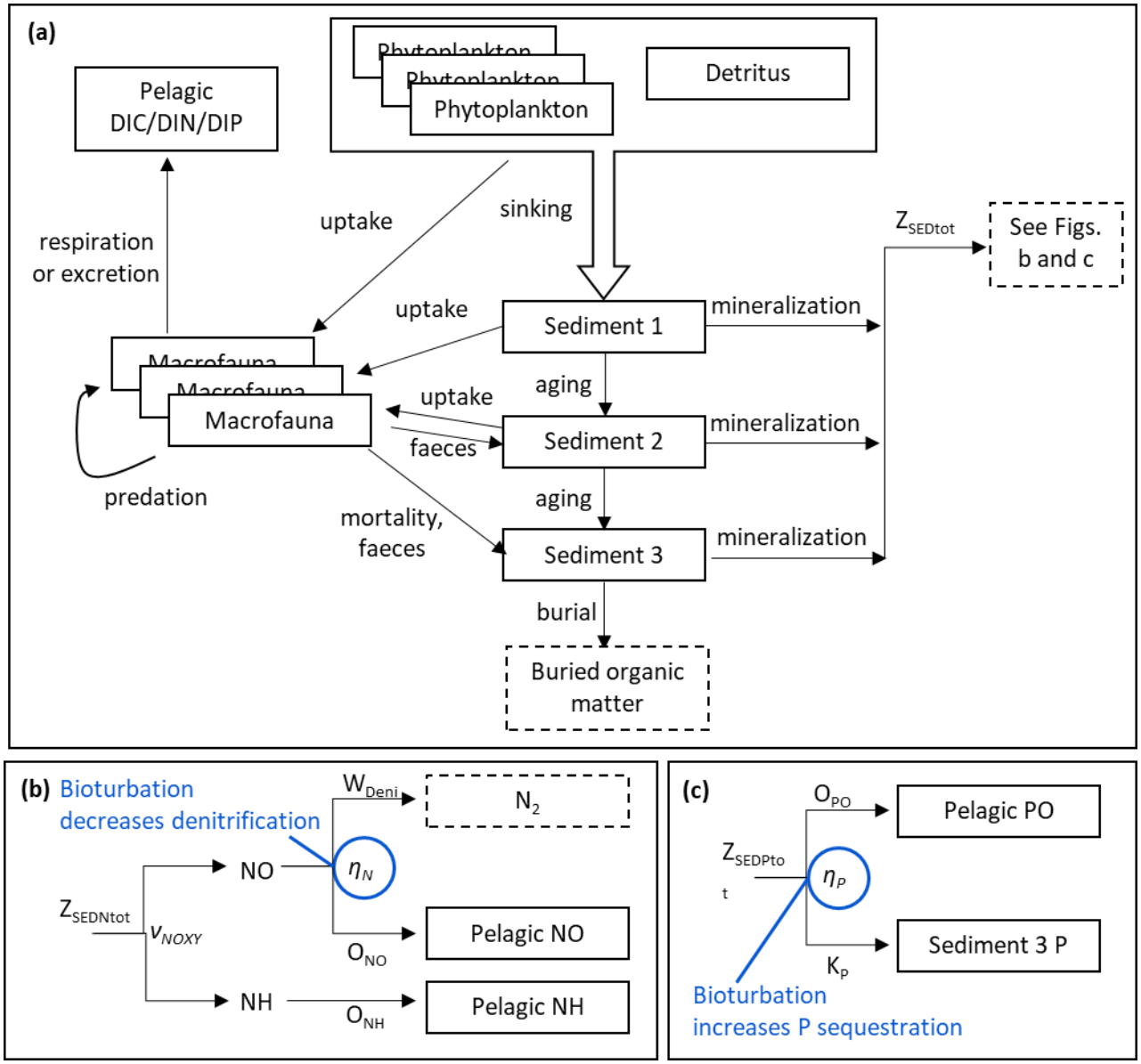

Figure 2. Schematic overview of benthic model processes shared by benthic C, N and P components (a) and apportionment of mineralization fluxes of sediment N (b) and P (c) with bioturbation effects indicated in blue.

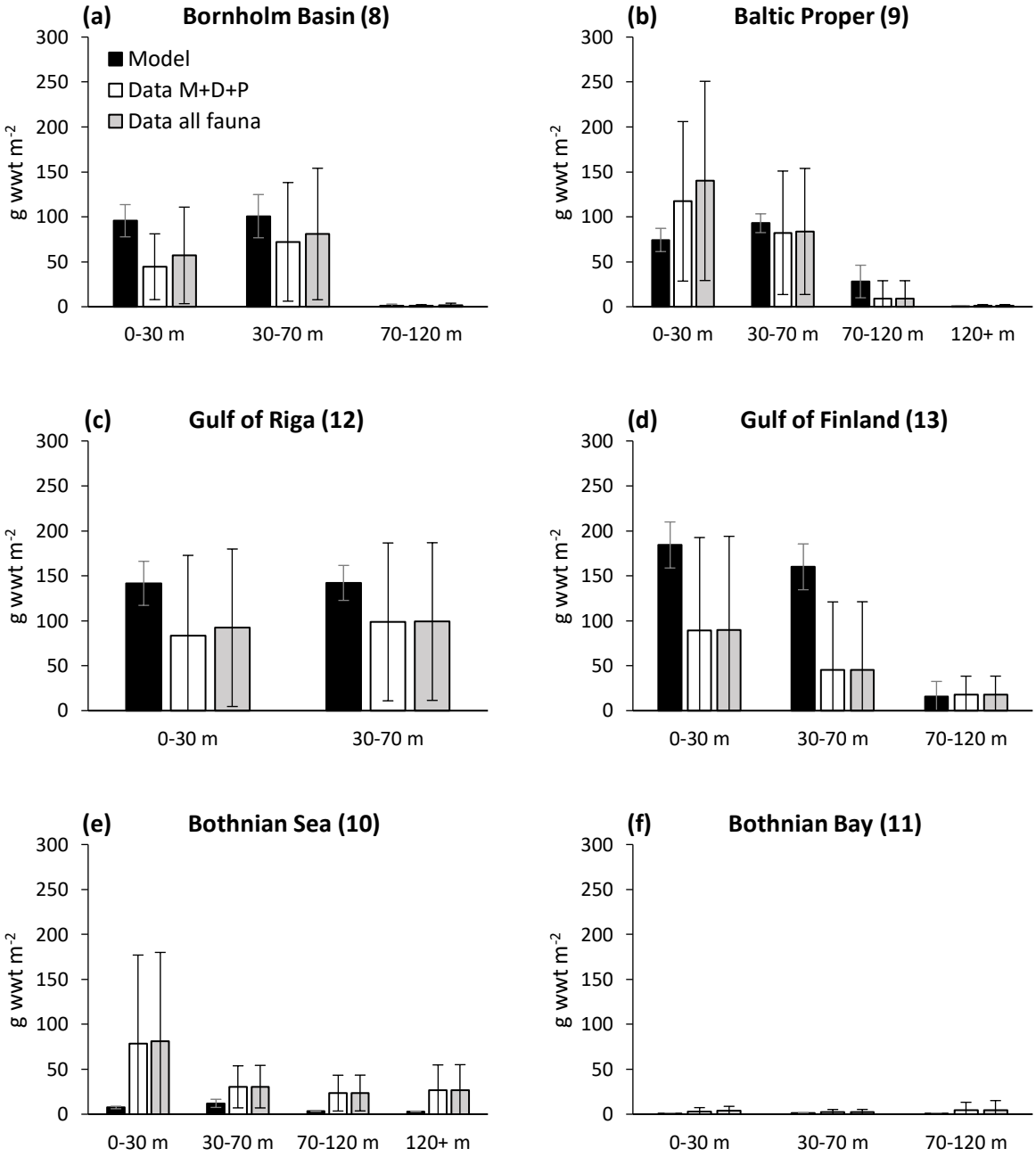

Figure 3. Comparison of simulated total biomasses of benthic fauna to observations at four depth intervals in six basins from south to north. Observations are shown both as the sum of the three functional groups *L. balthica*, surface deposit-feeders and predator/scavengers ('Data M+D+P') and total observed fauna. All data are shown as means ± standard deviations of 1990-2012, except for Arkona Basin 0-30 m where observational data from 1965-1979 were used as no other data were available. Numbers after basin names refer to basin numbers in Fig. 1**.** Numbers of samples and further comparisons are presented in Appendix C.

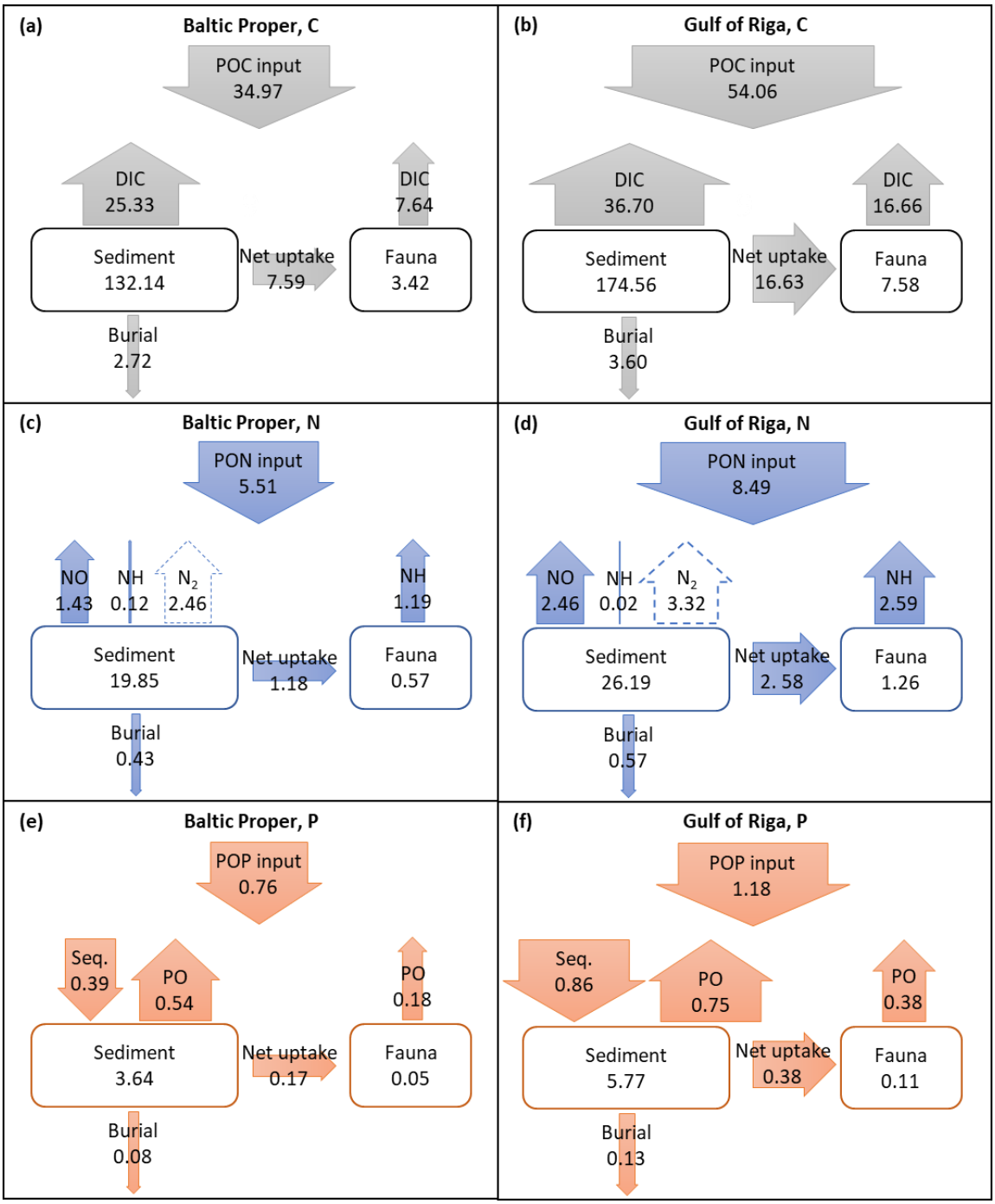

Figure 4. Average (2000-2020) benthic fluxes (g m^{-2} day^{-1}) and stocks (g m^{-2}) of C (a, b), N (c, d) and P (e, f) in the Baltic Proper (0–90 m, left column) and Gulf of Riga (right column). Arrow widths are proportional to fluxes for each element. Seq. = P sequestration.

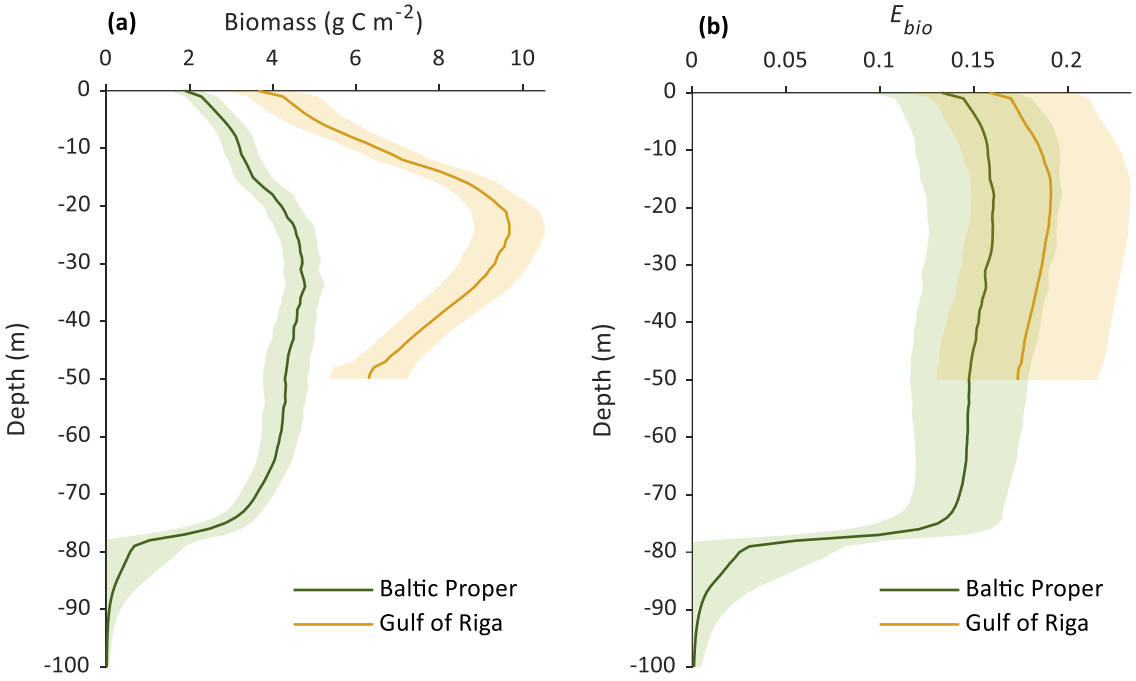

Figure 5. Depth distribution of benthic fauna biomass and the bioturbation coefficient E_{bio} in the upper 100 m of the Baltic Proper and Gulf of Riga. Averages (lines) and standard deviations (shaded areas) of biweekly values 2000-2020 in the default model run (E_{max} = 0.3).

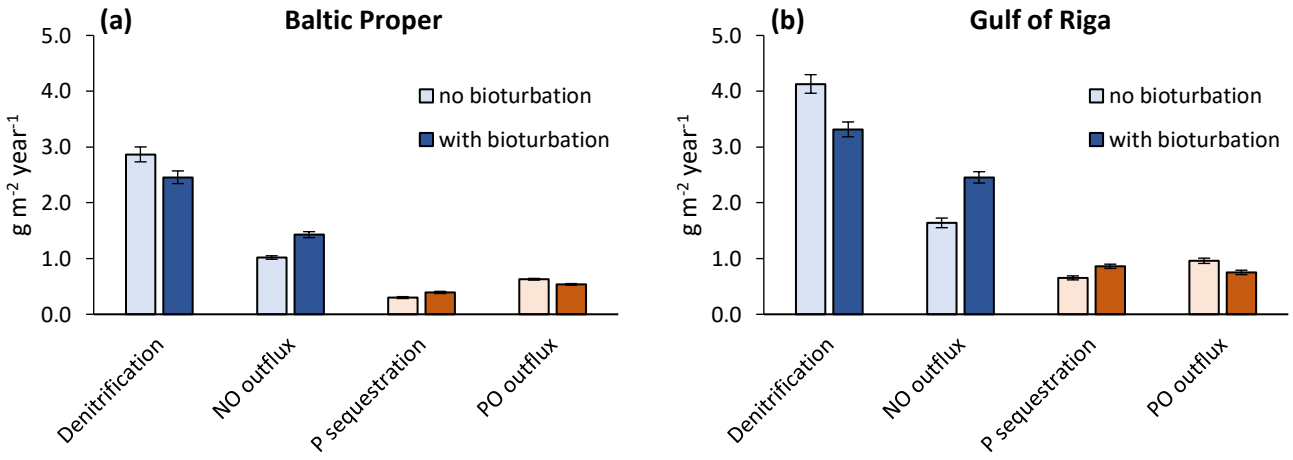

Figure 6. Direct effects of bioturbation on benthic fluxes. Benthic fluxes directly affected by bioturbation in the default run with bioturbation and when calculated for each time-step without bioturbation. Averages for 2000–2020 ± standard deviations in the Baltic Proper (0–90 m depth, a) and Gulf of Riga (b). Note that 'outflux' refers to the flux from sediments to the water column without animal excretion.

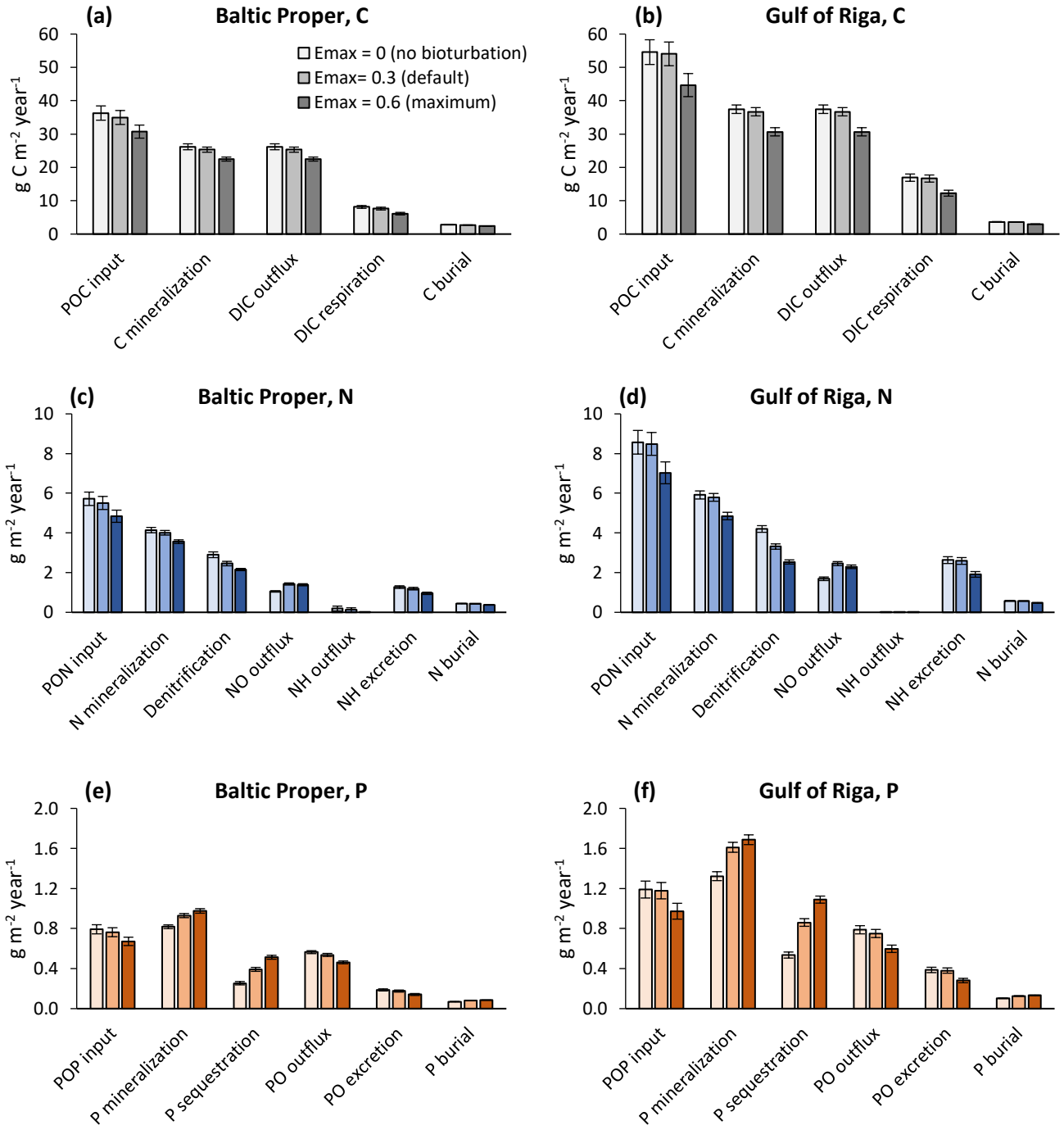

Figure 7. Sensitivity analysis of effects of three levels of bioturbation on benthic fluxes of carbon (a, b), nitrogen (c, d) and phosphorus (e, f). Averages for 2000–2020 ± standard deviations in the Baltic Proper (0–90 m depth, left column) and Gulf of Riga (right column). Note that animal excretion is shown separately and not included in 'mineralization' or 'outflux'.

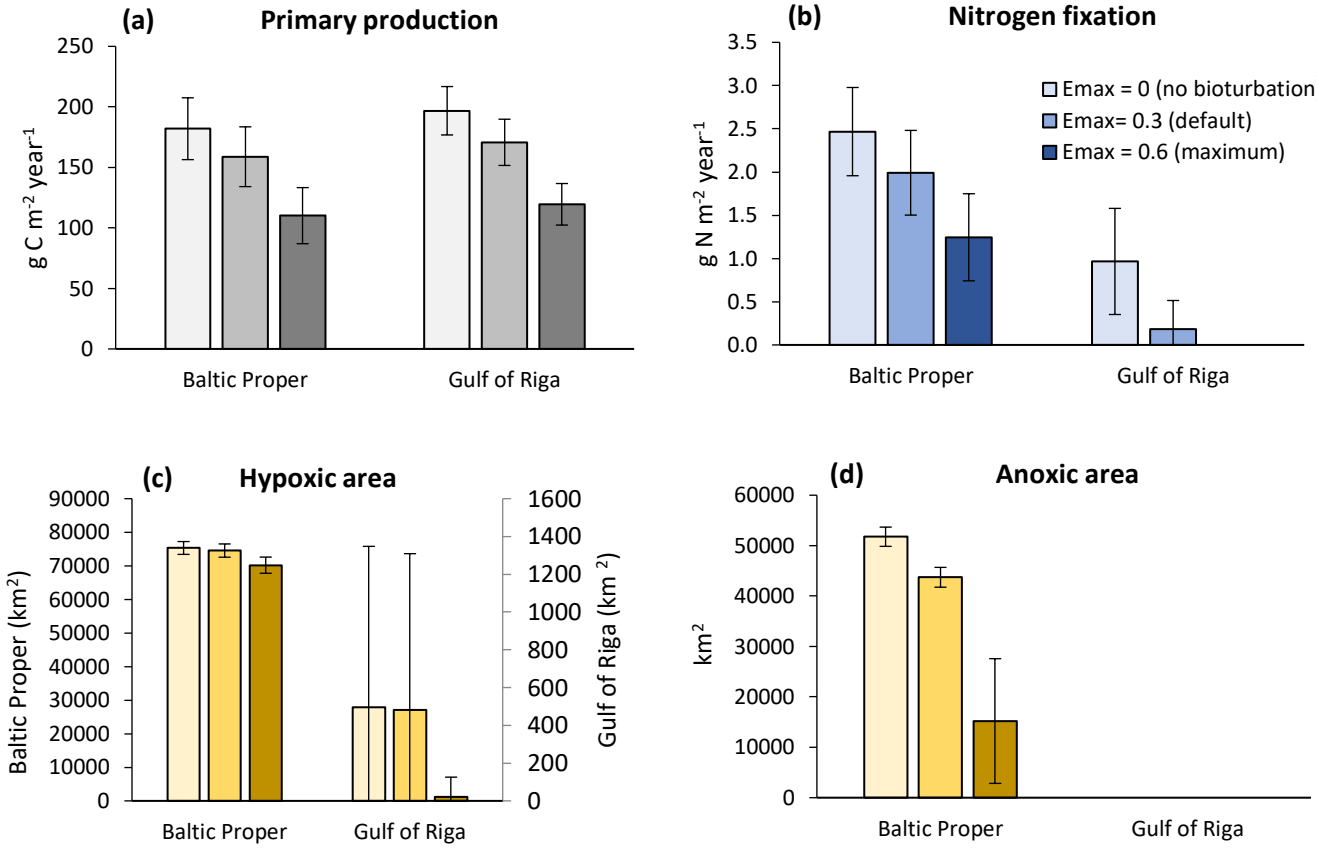

Figure 8. Sensitivity analysis of effects of three levels of bioturbation on total primary production (a), N fixation by cyanobacteria (b), hypoxic area (c) and anoxic area (d). The hypoxic and anoxic areas are defined as the annual maximum extent of areas with oxygen concentration < 2 mg 0_2 l^{-1} and 0 mg 0_2 l^{-1}, respectively. Averages for 2000–2020 ± standard deviations in the Baltic Proper and Gulf of Riga.

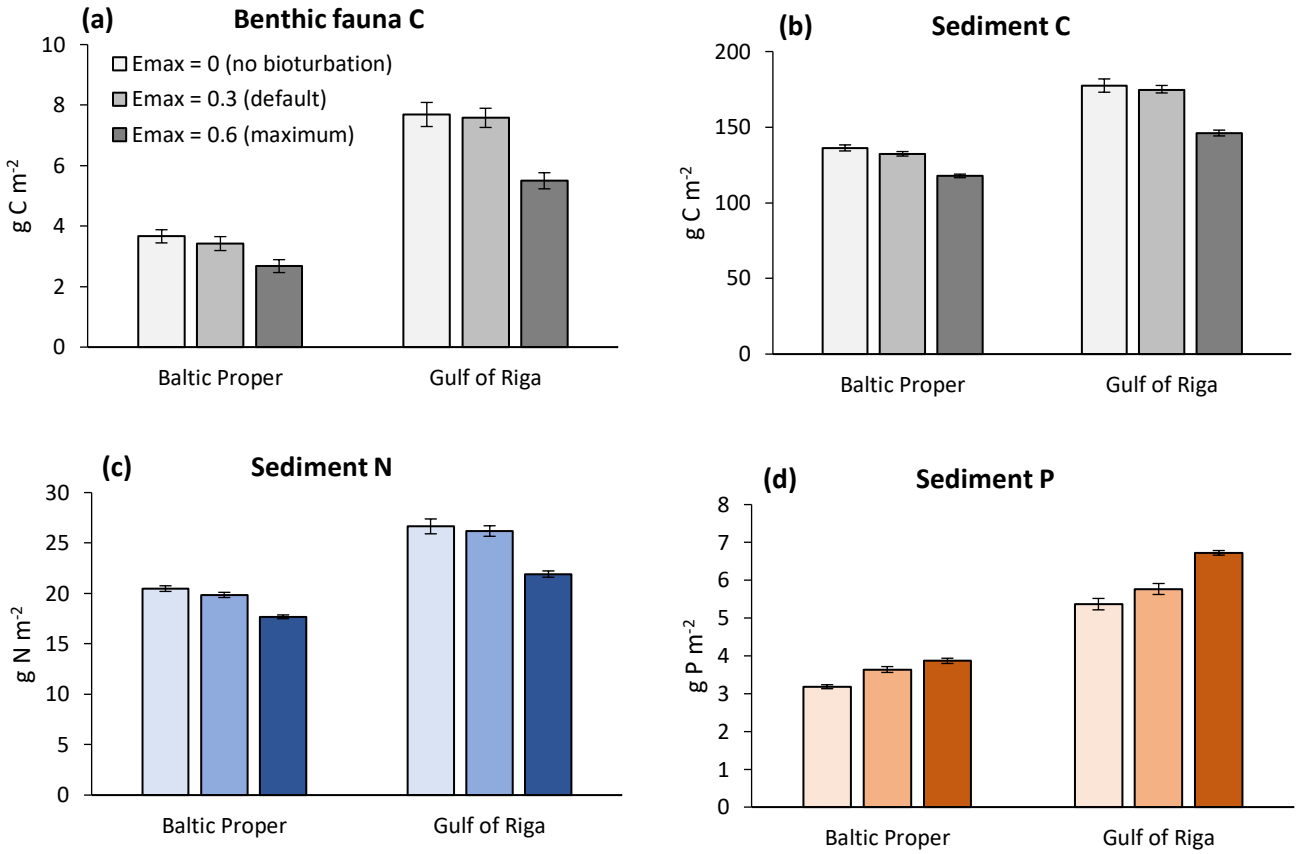

Figure 9. Sensitivity analysis of effects of three levels of bioturbation on stocks of benthic fauna and sediment C, N and P. Averages for 2000–2020 ± standard deviations in the Baltic Proper (0–90 m depth) and Gulf of Riga.

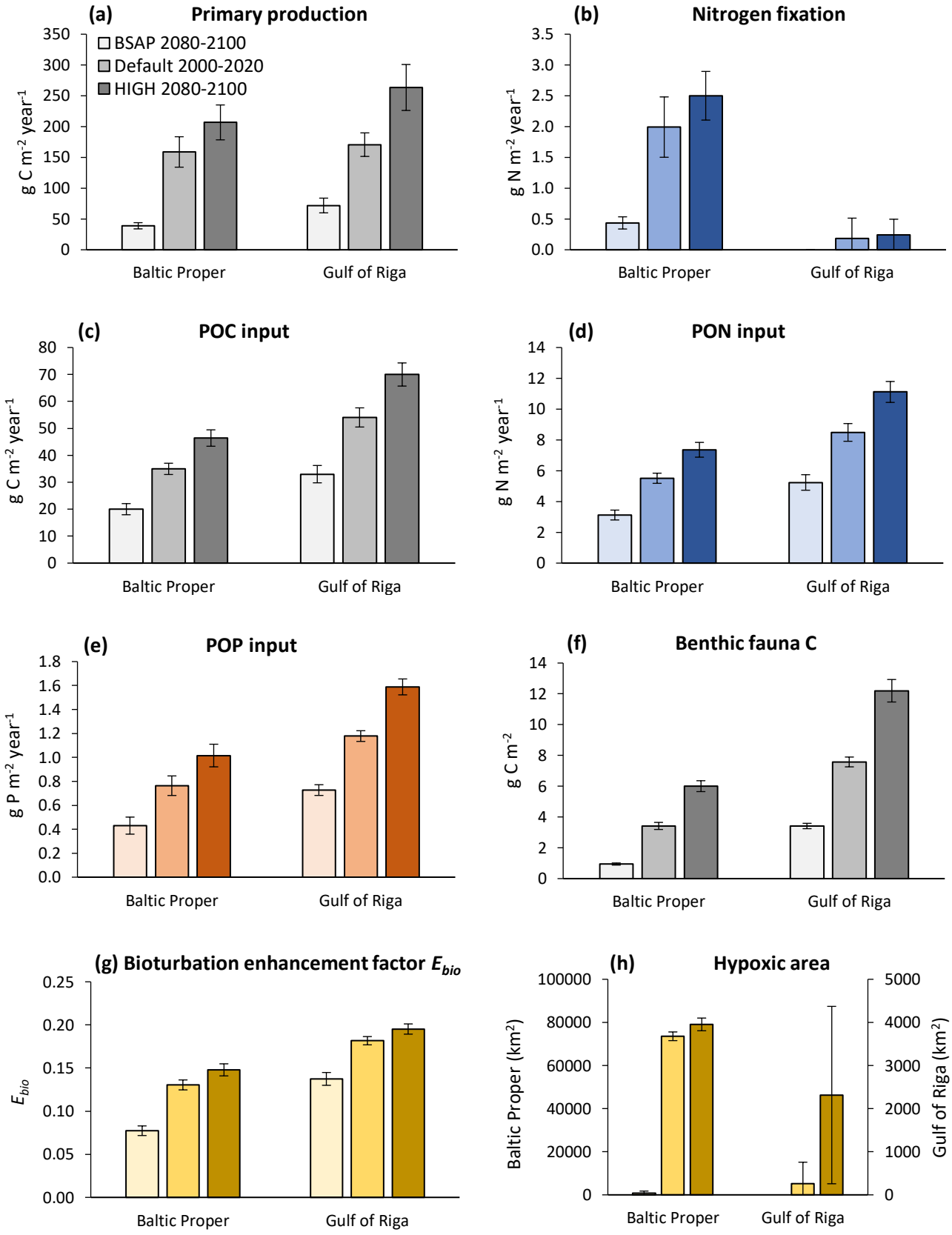

Figure 10. Primary production (a), nitrogen fixation (b), input of POC (c), PON (d) and POP (e) to the sediment, stocks of benthic fauna (f), bioturbation enhancement coefficient (g) and hypoxic area (h) in the default model run 2000-2020 and in two nutrient load scenarios 2080-2100 in the Baltic Proper (0–90 m depth) and Gulf of Riga. The hypoxic area is defined as the annual maximum extent of areas with oxygen concentration < 2 mg 0_2 l^{-1} and is given for the whole basins.

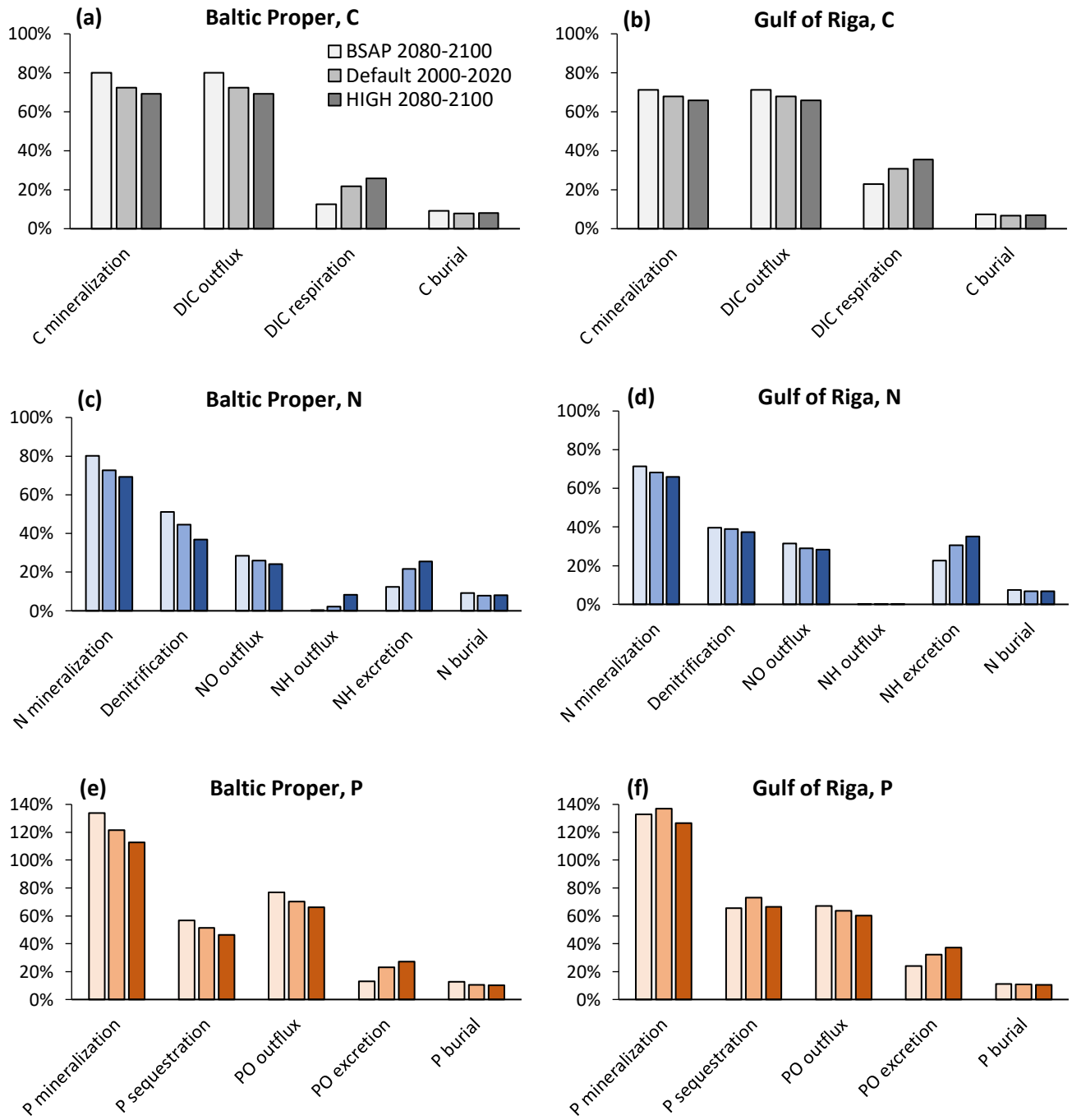

Figure 11. Apportionment of benthic fluxes of carbon (a, b), nitrogen (c, d) and phosphorus (e, f) in the default model run 2000-2020 and in two nutrient load scenarios 2080-2100 in the Baltic Proper (0–90 m depth, left column) and Gulf of Riga (right column). Fluxes are shown as percent of POM input to the sediment. Note that animal excretion is shown separately and not included in 'mineralization' or 'outflux'.

Table 1. Comparison of simulated benthic fauna biomass in the Gulf of Riga and estimates based on field sampling (g wet weight m^{-2}).

Mean (g wwt m^{-2})	Range (g wwt m^{-2})	Source	Comment
154	29 to 284	Model	1970–2020
64	<2 to >300	(Gogina et al., 2016)	
46	38 to 200	(Järvekülg, 1983)	Unit uncertain, given as g m^{-2}
350	160 to 370	(Kotta et al., 2008)	Assuming 10% dwt wwt^{-1}
38	1 to 188	(Witek, 1995)	SW part only
78	13 to 371	(Cederwall et al., 1999; Gaumiga and Lagzdins, 1995)	1974–1979
208	49 to 340	(Gaumiga and Lagzdins, 1995)	1984–1985
196	<50 to 1311	(Cederwall et al., 1999)	1985–1989
113	<50 to 800	(Cederwall et al., 1999)	1993–1996

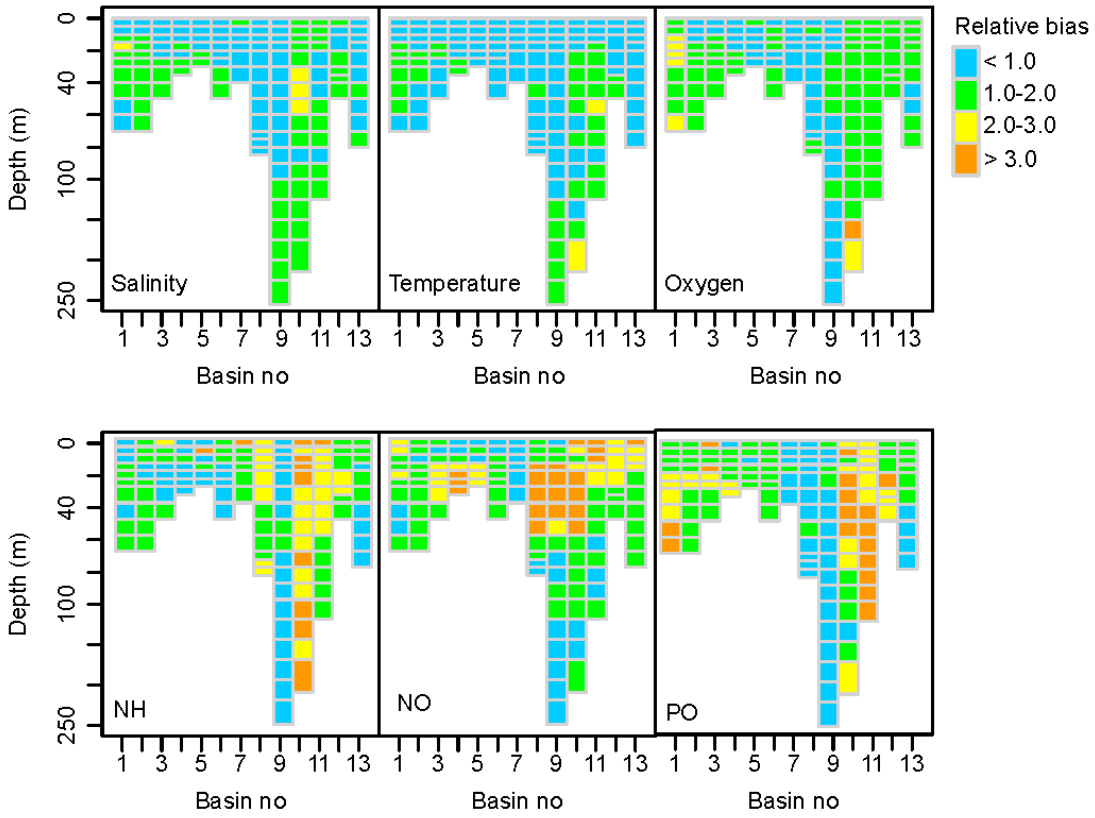

Figure B1. Spatial distribution of the relative bias between simulated and observed dynamics of salinity, temperature, and concentrations of oxygen, total ammonia (NH), nitrate + nitrite (NO) and total phosphate (PO) 1970-2015. See Fig. 1 for a map of basins.

Table C1. Number of observations of benthic fauna wet weight used for model validation per basin and depth interval. Total N = 7774. Note that replicate samples are counted as individual observations.

Depth interval	Kattegat (1-3)	Öresund (6)	Arkona Basin (7)	Bornholm Basin (8)	Baltic Proper (9)	Gulf of Riga (12)	Gulf of Finland (13)	Bothnian Sea (10)	Bothnian Bay (11)
0-30 m	864	623	6	412	292	73	10	408	144
30-70 m	488	0	143	279	822	22	284	880	306
70-120 m	65			49	330		78	479	486
120+ m					58			173	
Total	**1417**	**623**	**149**	**740**	**1502**	**95**	**372**	**1940**	**936**

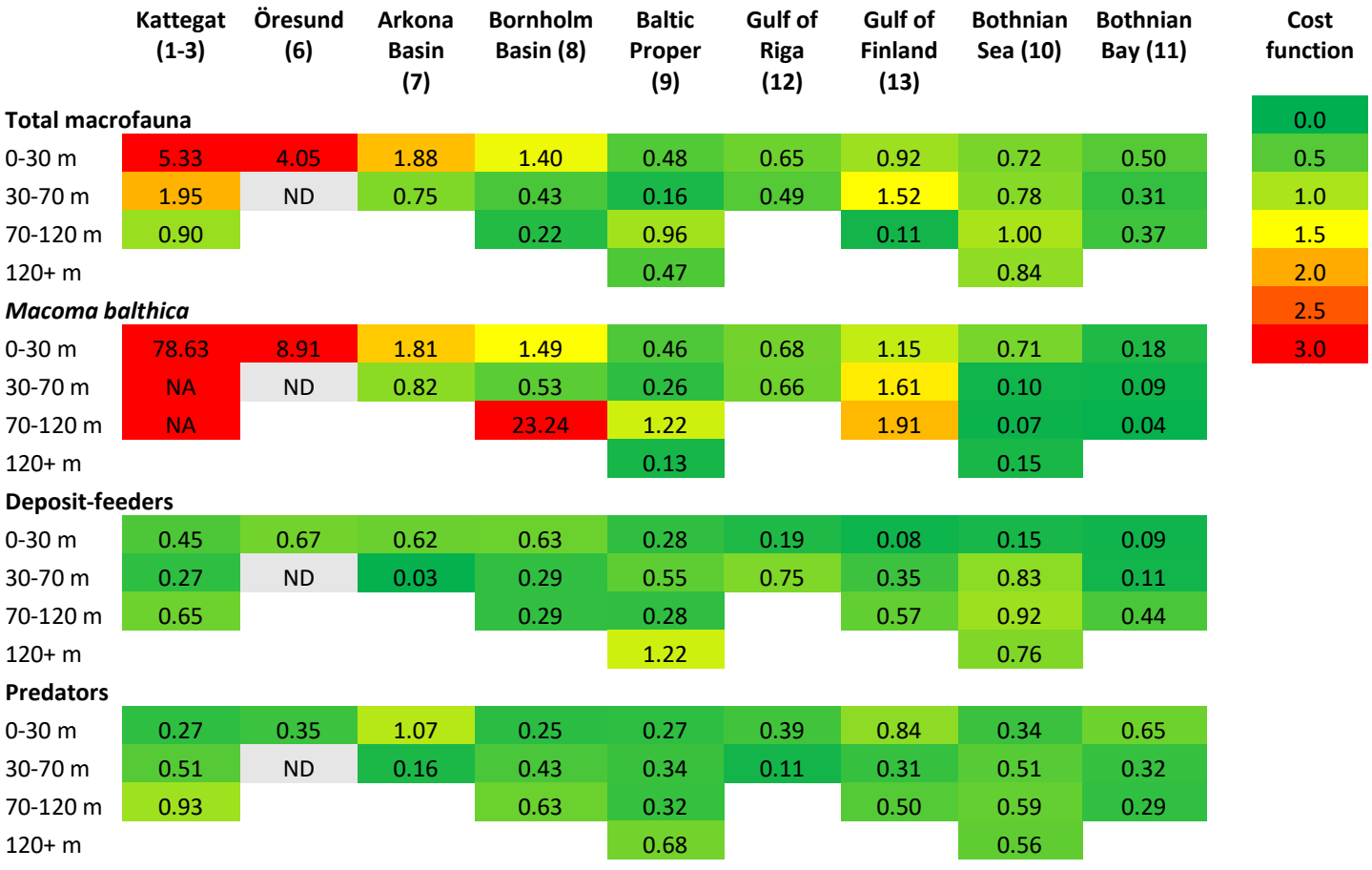

Figure C1. Cost functions comparing simulated and observed biomasses of benthic fauna. ND: no data. NA: Not applicable; in the deeper sections of Kattegat, observed biomasses of *M. balthica* are 0, i.e. CF cannot be computed.

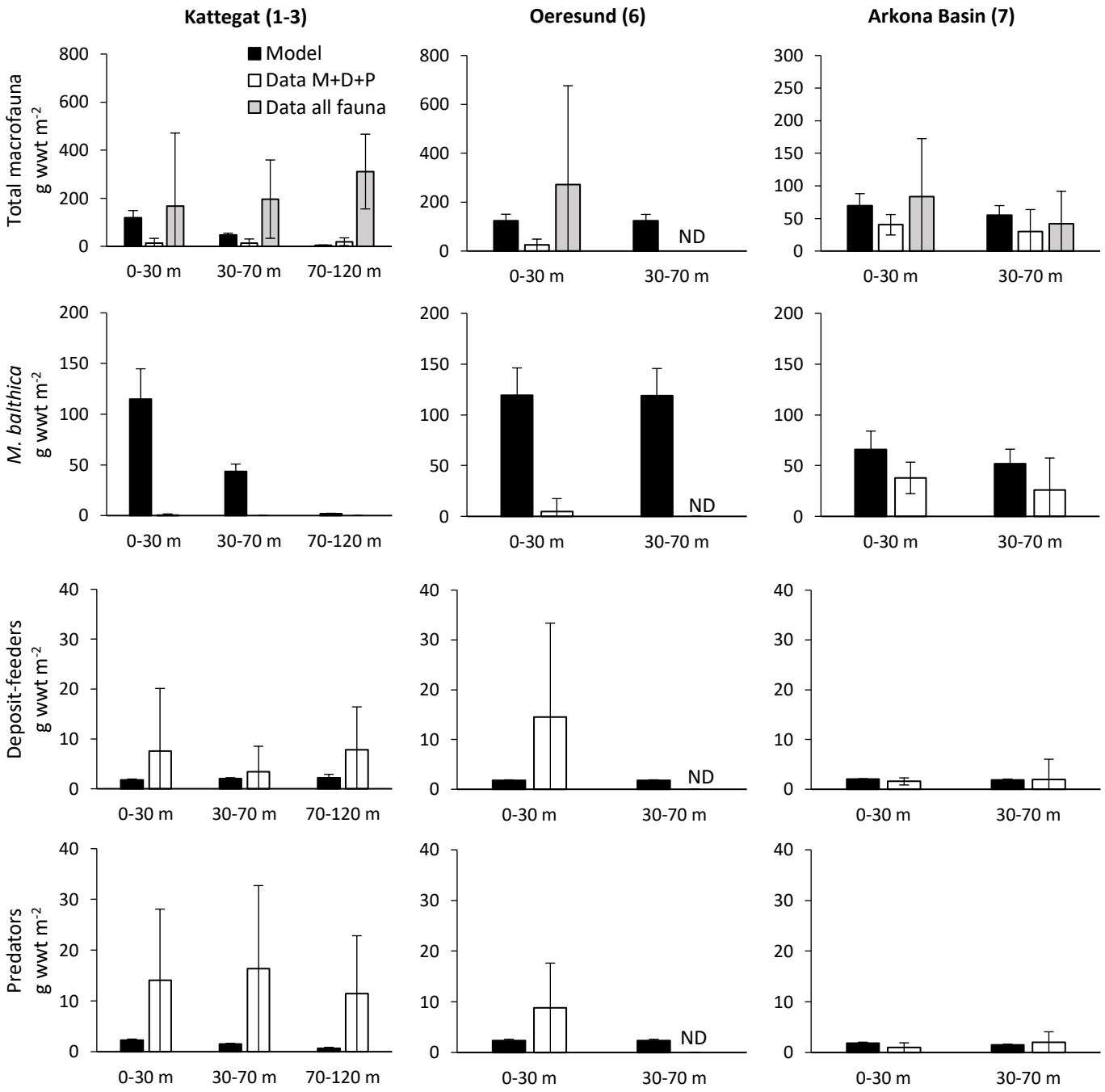

Figure C2. Comparison of simulated biomasses of benthic fauna to observations at four depth intervals in BALTSEM basins from south to north. Observations are shown both as the sum of the three functional groups *M. balthica*, surface deposit-feeders and predator/scavengers ('Data M+D+P') and total observed fauna ('Data all fauna'), including other groups such as suspension-feeders, freshwater herbivores and large echinoderms. All data is given as means ± standard deviations of 1990-2012, except for Arkona Basin 0-30 m where data from 1965-1979 was used as no other data was available. Numbers after basin names refer to basin numbers in Fig. 1. ND: no data.

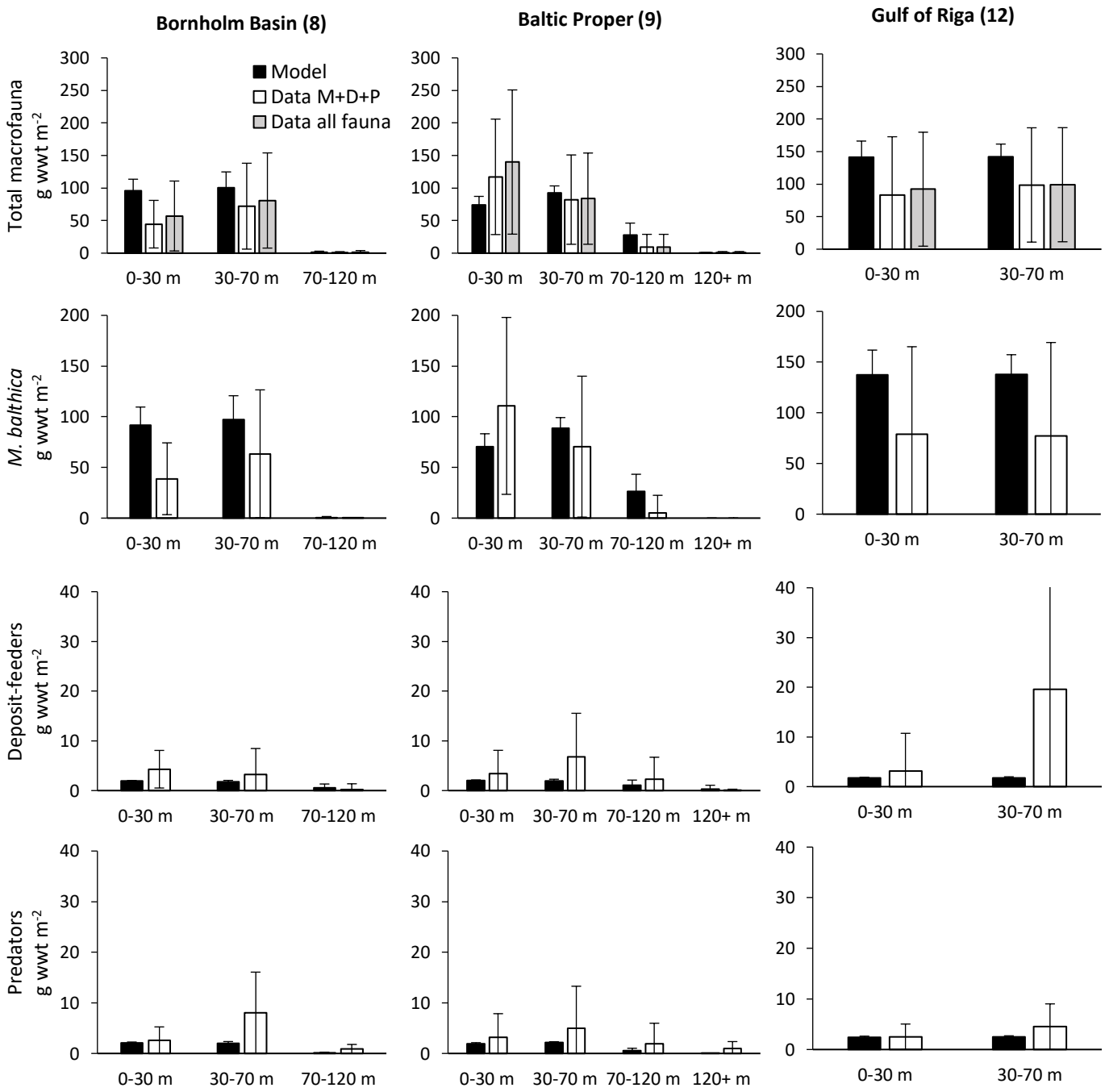

Figure C2. continued

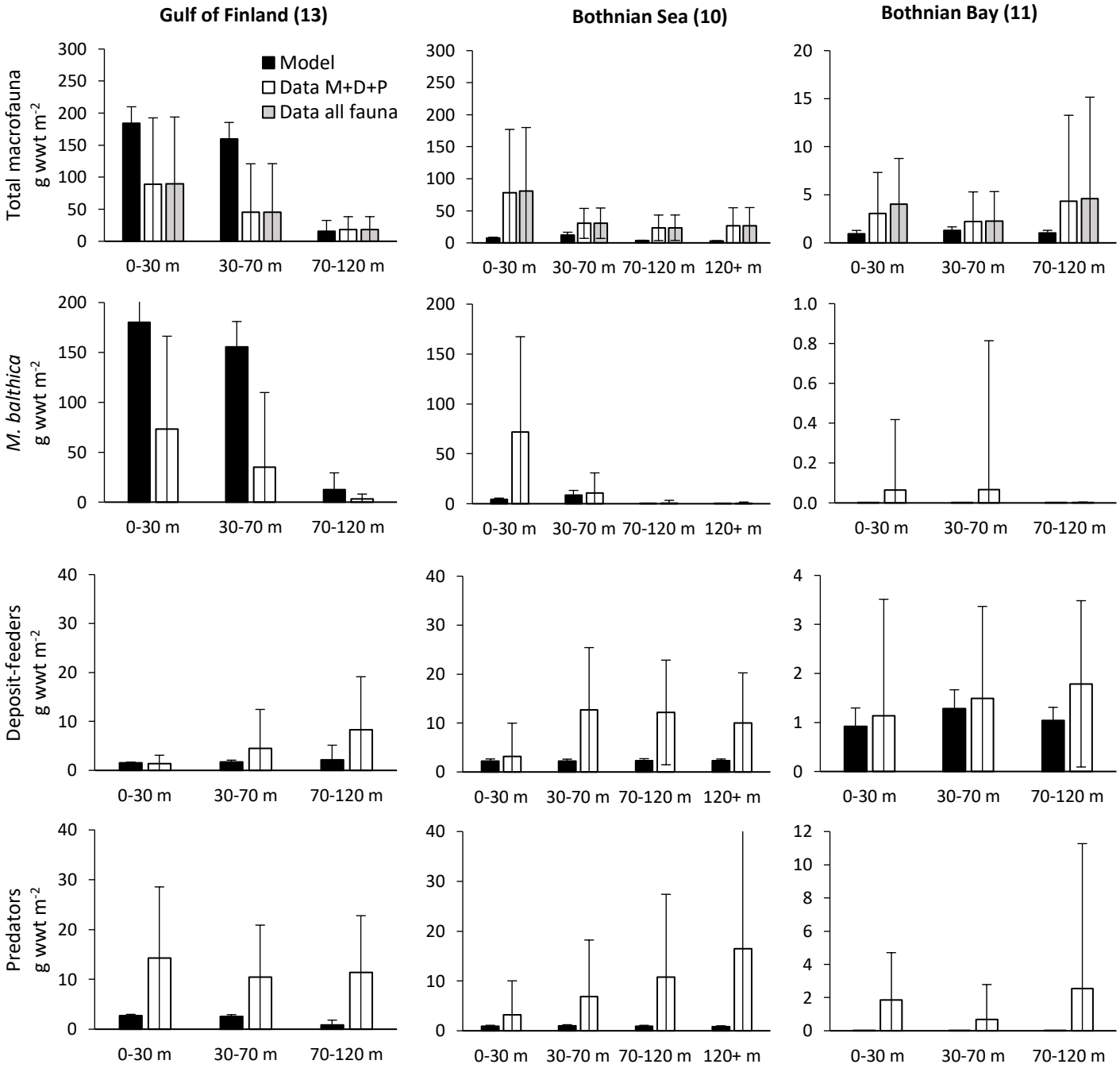

Figure C2. continued. Note different scales on y-axes for the Bothnian Bay.