

TITLE: Global ensemble projections reveal trophic amplification of ocean biomass declines with climate change

AUTHOR: ['Heike K. Lotze', 'Derek P. Tittensor', 'Andrea Bryndum?Buchholz', 'Tyler D. Eddy', 'William W. L. Cheung', 'Eric D. Galbraith', 'Manuel Barangé', 'Nicolas Barrier', 'Daniele Bianchi', 'Julia L. Blanchard', 'Laurent Bopp', 'Matthias Büchner', 'C. M. Bulman', 'David A. Carozza', 'Villy Christensen', 'Marta Coll', 'John Dunne', 'Elizabeth A. Fulton', 'Simon Jennings', 'Miranda C. Jones', 'Steven Mackinson', 'Olivier Maury', 'Susa Niiranen', 'Ricardo Oliveros?Ramos', 'Tilla Roy', 'José António Fernandes', 'Jacob Schewe', 'Yunne?Jai Shin', 'Tiago Silva', 'Jeroen Steenbeek', 'Charles A. Stock', 'Philippe Verley', 'Jan Volkholz', 'Nicola Walker', 'Boris Worm']

ABSTRACT:

While the physical dimensions of climate change are now routinely assessed through multimodel intercomparisons, projected impacts on the global ocean ecosystem generally rely on individual models with a specific set of assumptions. To address these single-model limitations, we present standardized ensemble projections from six global marine ecosystem models forced with two Earth system models and four emission scenarios with and without fishing. We derive average biomass trends and associated uncertainties across the marine food web. Without fishing, mean global animal biomass decreased by 5% ($\pm 4\%$ SD) under low emissions and 17% ($\pm 11\%$ SD) under high emissions by 2100, with an average 5% decline for every 1 °C of warming. Projected biomass declines were primarily driven by increasing temperature and decreasing primary production, and were more pronounced at higher trophic levels, a process known as trophic amplification. Fishing did not substantially alter the effects of climate change. Considerable regional variation featured strong biomass increases at high latitudes and decreases at middle to low latitudes, with good model agreement on the direction of change but variable magnitude. Uncertainties due to variations in marine ecosystem and Earth system models were similar. Ensemble projections performed well compared with empirical data, emphasizing the benefits of multimodel inference to project future outcomes. Our results indicate that global ocean animal biomass consistently declines with climate change, and that these impacts are amplified at higher trophic levels. Next steps for model development include dynamic scenarios of fishing, cumulative human impacts, and the effects of management measures on future ocean biomass trends.

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