

ID: W2900131078

TITLE: Twenty-first-century climate change impacts on marine animal biomass and ecosystem structure across ocean basins

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ABSTRACT:

Abstract Climate change effects on marine ecosystems include impacts on primary production, ocean temperature, species distributions, and abundance at local to global scales. These changes will significantly alter marine ecosystem structure and function with associated socio-economic impacts on ecosystem services, marine fisheries, and fishery-dependent societies. Yet how these changes may play out among ocean basins over the 21st century remains unclear, with most projections coming from single ecosystem models that do not adequately capture the range of model uncertainty. We address this by using six marine ecosystem models within the Fisheries and Marine Ecosystem Model Intercomparison Project (Fish-MIP) to analyze responses of marine animal biomass in all major ocean basins to contrasting climate change scenarios. Under a high emissions scenario (RCP8.5), total marine animal biomass declined by an ensemble mean of 15%–30% ( $\pm 12\%$ – $17\%$ ) in the North and South Atlantic and Pacific, and the Indian Ocean by 2100, whereas polar ocean basins experienced a 20%–80% ( $\pm 35\%$ – $200\%$ ) increase. Uncertainty and model disagreement were greatest in the Arctic and smallest in the South Pacific Ocean. Projected changes were reduced under a low (RCP2.6) emissions scenario. Under RCP2.6 and RCP8.5, biomass projections were highly correlated with changes in net primary production and negatively correlated with projected sea surface temperature increases across all ocean basins except the polar oceans. Ecosystem structure was projected to shift as animal biomass concentrated in different size-classes across ocean basins and emissions scenarios. We highlight that climate change mitigation measures could moderate the impacts on marine animal biomass by reducing biomass declines in the Pacific, Atlantic, and Indian Ocean basins. The range of individual model projections emphasizes the importance of using an ensemble approach in assessing uncertainty of future change.

SOURCE: Global change biology

PDF URL: None

CITED BY COUNT: 147

PUBLICATION YEAR: 2018

TYPE: article

CONCEPTS: ['Marine ecosystem', 'Environmental science', 'Ecosystem', 'Biomass (ecology)', 'Climate change', 'Oceanography', 'Representative Concentration Pathways', 'Climate model', 'Ecology', 'Geology', 'Biology']