Climate-mediated changes in marine ecosystem regulation during El Niño - DTU Orbit

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The degree to which ecosystems are regulated through bottom-up, top-down or direct physical processes represents a long-standing issue in ecology, with important consequences for resource management and conservation. In marine ecosystems, the role of bottom-up and top-down forcing has been shown to vary over spatio-temporal scales, often linked to highly variable and heterogeneously distributed environmental conditions. Ecosystem dynamics in the Northeast Pacific have been suggested to be predominately bottom-up regulated. However, it remains unknown to what extent top-down regulation occurs, or whether the relative importance of bottom-up and top-down forcing may shift in response to climate change. In this study, we investigate the effects and relative importance of bottom-up, top-down and physical forcing during changing climate conditions on ecosystem regulation in the Southern California Current System (SCCS) using a generalized food web model. This statistical approach is based on non-linear threshold models and a long-term data set (~60 year) covering multiple trophic levels from phytoplankton to predatory fish. We found bottom-up control to be the primary mode of ecosystem regulation. However, our results also demonstrate an alternative mode of regulation represented by interacting bottom-up and top-down forcing, analogous to wasp-waist dynamics, but occurring across multiple trophic levels and only during periods of reduced bottom-up forcing (i.e., weak upwelling, low nutrient concentrations and primary production). The shifts in ecosystem regulation are caused by changes in ocean-atmosphere forcing and triggered by highly variable climate conditions associated with El Niño. Furthermore, we show that biota respond differently to major El Niño events during positive or negative phases of the Pacific Decadal Oscillation (PDO), as well as highlight potential concerns for marine and fisheries management by demonstrating increased sensitivity of pelagic fish to exploitation during El Niño. This article is protected by copyright. All rights reserved.

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