Climate-mediated changes in marine ecosystem regulation during El Niño - DTU Orbit
(12/10/2018)

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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.

General information
State: Published
Organisations: National Institute of Aquatic Resources, Centre for Ocean Life, University of California at San Diego
Contributors: Lindegren, M., Checkley, D. M., Koslow, J. A., Goericke, R., Ohman, M. D.
Pages: 796-809
Publication date: 2017
Peer-reviewed: Yes

Publication information
Journal: Global Change Biology
Volume: 24
Issue number: 2
ISSN (Print): 1354-1013
Ratings:
BFI (2018): BFI-level 2
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 2
Scopus rating (2017): CiteScore 9.12 SJR 4.731 SNIP 2.842
Web of Science (2017): Impact factor 8.997
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 8.75 SJR 4.938 SNIP 2.588
Web of Science (2016): Impact factor 8.502
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): CiteScore 8.48 SJR 5.206 SNIP 2.565
Web of Science (2015): Impact factor 8.444
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): CiteScore 8.33 SJR 4.663 SNIP 2.675
Web of Science (2014): Impact factor 8.044
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 2
Scopus rating (2013): CiteScore 8.4 SJR 4.634 SNIP 2.65
Web of Science (2013): Impact factor 8.224
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes