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TITLE: Defining ecosystem thresholds for human activities and environmental pressures in the California Current

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ABSTRACT:

Abstract The oceans are changing more rapidly than ever before. Unprecedented climatic variability is interacting with unmistakable long?term trends, all against a backdrop of intensifying human activities. What remains unclear, however, is how to evaluate whether conditions have changed sufficiently to provoke major responses of species, habitats, and communities. We developed a framework based on multimodel inference to define ecosystem?based thresholds for human and environmental pressures in the California Current marine ecosystem. To demonstrate how to apply the framework, we explored two decades of data using gradient forest and generalized additive model analyses, screening for nonlinearities and potential threshold responses of ecosystem states ( n = 9) across environmental ( n = 6) and human ( n = 10) pressures. These analyses identified the existence of threshold responses of five ecosystem states to four environmental and two human pressures. Both methods agreed on threshold relationships in two cases: (1) the winter copepod anomaly and habitat modification, and (2) sea lion pup production and the summer mode of the Pacific Decadal Oscillation ( PDO ). Considered collectively, however, these alternative analytical approaches imply that as many as five of the nine ecosystem states may exhibit threshold changes in response to negative PDO values in the summer (copepods, scavengers, groundfish, and marine mammals). This result is consistent with the idea that the influence of the PDO extends across multiple trophic levels, but extends current knowledge by defining the nonlinear nature of these responses. This research provides a new way to interpret changes in the intensities of human and environmental pressures as they relate to the ecological integrity of the California Current ecosystem. These insights can be used to make more informed assessments of when and under what conditions intervention, preparation, and mitigation may enhance progress toward ecosystem?based management goals.

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