

GLOBEC Pan-regional Synthesis:  
**Pacific Ocean Boundary Ecosystems:**  
**response to natural and anthropogenic climate forcing**

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**Intellectual Merits:** Large-scale decadal Pacific climate indices such as the Pacific Decadal Oscillation (PDO) have been linked to changes across multiple trophic levels of marine ecosystems along the eastern and western boundaries. Recent studies of the Northeast Pacific by the PIs show that other independent climate modes are equally important in explaining changes in coastal ocean upwelling and transport dynamics – the fundamental processes controlling regional nutrient fluxes and planktonic ecosystem dynamics. This suggests that the interplay of forcing functions associated with multiple large-scale climate modes must be considered to adequately diagnose the dynamics and mechanics underlying variations in regional ecosystems. With this framework, our study combines extensive national and international in situ and satellite observations with numerical and statistical physical-biological models to diagnose the response of four Pacific boundary ecosystems to large-scale natural and anthropogenic climate forcing. The focus regions are: *the Gulf of Alaska (GOA), the California Current System (CCS), the Peru-Chile Current System (PCCS), and the Kuroshio-Oyashio Extension (KOE) region*. We approach this goal through four core research objectives. **(1)** Assess to what extent, and by what mechanisms, large-scale climate modes (e.g. PDO, NPGO, ENSO, and others) drove coherent changes across Pacific boundary ecosystems over the period 1960-2007. **(2)** Quantify and explain how changes in regional ocean processes (e.g. upwelling, transport dynamics, mixing and mesoscale structure) at each boundary control phytoplankton and zooplankton dynamics. Then, use those results to test the degree to which changes in each study region reflect bottom-up control of their respective ecosystems. **(3)** Quantify the extent to which changes in the statistics of shorter-period events (e.g. intraseasonal oscillation, timing of spring transitions) during different phases of the longer-period climate modes (e.g. PDO, NPGO and others) determine the climate state of boundary-current ecosystems. Finally, **(4)** explore the range of uncertainties in the response of regional ocean dynamics and their ecosystems to climate change using forcing scenarios from selected climate model integrations that are part of the IPCC 2007 report. This last objective begins an assessment of the potential impacts of climate change on regional ocean ecosystems, a topic poorly addressed in the latest IPCC report, but the chief instrument for most fisheries and coastal management.

The success of these analyses relies on the diverse expertise of the PI's, which include physical-biological observations (*Keister, Peterson, Strub, Bograd and Thomas*), numerical regional ocean-ecosystem modeling (*Di Lorenzo, Franks, Bracco and Chhak*), statistical physical-biological modeling (*Mendelssohn, Peterson, Schwing and Di Lorenzo*) and IPCC coupled climate model projections (*Chhak*). These PIs are supported by a collaborative team from Chile, Japan and Canada.

**Broader Impacts:** This study will provide an improved and unified understanding of low-frequency ecosystem dynamics in the economically vital eastern and western boundaries of the Pacific Ocean. It will also deliver new methodologies for assessing the uncertainties associated with regional climate change in marine ecosystems with direct implication for fisheries management and future assessment of the IPCC. The project team represents a close collaboration of academic and government scientists, and the research will be conducted with the support of international collaborators from South America, Japan and Canada. These collaborations will provide training for both international and US students through scientific exchanges, expanding the international network for both the PIs and foreign collaborators. Four young PIs will be supported (*E. Di Lorenzo, J. Keister, K. Chhak and A. Bracco*), including three female scientists, two of which have no previous NSF support or other sources of funding. Activities and results from this project will also extend to the undergraduate students through REU programs, and underserved high-school students through the SMILE (Science and Math Investigative Learning Experiences) Program.