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Effects of Elevated Sea Levels and Waves on Southern California Estuaries During the 2015–2016 El Niño

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ABSTRACT

Ocean acidification (OA) along the US West Coast is intensifying faster than observed in the global ocean. This is particularly true in near shore regions (<200 m) that experience a lower buffering capacity while at the same time providing important habitats for ecologically and economically significant species. While the literature on the effects of OA from laboratory experiments is voluminous, there is little understanding of present-day OA in-situ effects on marine life. Dungeness crab (Metacarcinus magister) is perennially one of the most valuable commercial and recreational fisheries. We focused on establishing OA-related vulnerability of larval crustacean based on mineralogical and elemental carapace to external and internal carapace dissolution by using a combination of different methods ranging from scanning electron microscopy, energy dispersive X-ray spectroscopy, elemental mapping and X-ray diffraction. By integrating carapace features with the chemical observations and biogeochemical model hindcast, we identify the occurrence of external carapace dissolution related to the steepest Ω calcite gradients ($\Delta\Omega_{cal,60}$) in the water column. Dissolution features are observed across the carapace, pereopods (legs), and around the calcified areas surrounding neuritic canals of mechanoreceptors. The carapace dissolution is the most extensive in the coastal habitats under prolonged (1-month) long exposure, as demonstrated by the use of themodel hindcast. Such dissolution has a potential to destabilize mechanoreceptors with important sensory and behavioral functions, a pathway of sensitivity to OA. Carapace dissolution is negatively related to crab larval width, demonstrating a basis for energetic trade-offs. Using a retrospective prediction from a regression models, we estimate an 8.3% increase in external carapace dissolution over the last two decades and identified a set of affected OA-related sublethal pathways to inform future risk assessment studies of Dungeness crabs.