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Historical kelp forests in California over multiple centuries

[Selgrath, Jennifer](#) ¹ ; [Carlton, James](#) ² ; [Pearse, John](#) ³ ; [Thomas, Timothy](#) ⁴ ;
[Micheli, Fiorenza](#) ¹

[Author affiliations](#) ▼

Research facility: [Stanford University](#)

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Abstract

Kelp forests have deteriorated globally due to anthropogenic stressors. There is an urgent need to extend baselines, to understand the processes that underlie the persistence and recovery of kelp forests, and to distinguish the normal range of ecosystem variability from more extreme changes. Using a mixed-method, historical ecology approach we integrate archival data, oral histories, and contemporary ecological data to examine the dynamics of kelp forests over a multi-decadal to multi-century time period in central California. We focus on sea otters, sunflower seastars, sea urchins, kelp cover, kelp species dynamics, and climate. From 1826 to 2020 kelp was highly variable. There were seven periods of low kelp cover and two periods of exceptionally low kelp cover (1896-1899; 2014-2016) following El Niño-Southern Oscillations (ENSOs). Exceptionally low kelp cover did not occur when two predators – seastars and sea otters – were present. In all cases, kelp recovered following times of extremely low cover, with a

lag, which was extended by the duration of warm water anomalies. We present the concept of an ENSO Recovery Lag - a metric indicating the time it takes for kelp to recover following ENSO events. Kelp remained low for approximately two years following 80% of ENSOs. The greatest kelp decline (12-fold) was in Santa Cruz (northern Monterey Bay). Herbivore populations (sea urchins) were highly variable over the past century and exhibited short and long-term changes in abundance. Sunflower seastars were present in low, stable abundances prior to seastar wasting disease (1938-2013 mean density: 0.02/m²) when they declined by 97.5%. Insights from this reconstruction indicate that kelp recovery following extended warm water anomalies exhibits a lag, and occurs over multiple years.

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Dataset

 <https://exhibits.stanford.edu/data/browse/monterey-bay-historical-ecology-and-biodiversity>

Software

 <https://github.com/jselgrath/Historical KelpForests>

 <https://doi.org/10.5281/zenodo.12561615>

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