

# Is El Niño Driving Poleward Range Expansion of Marine Organisms?



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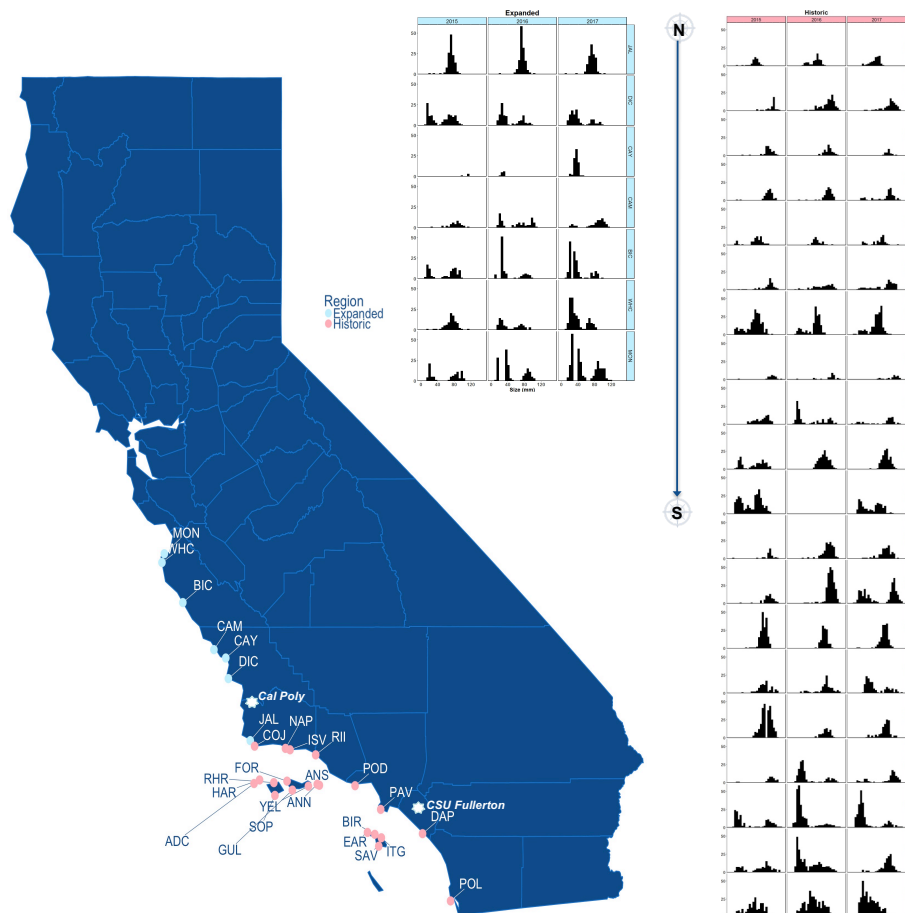
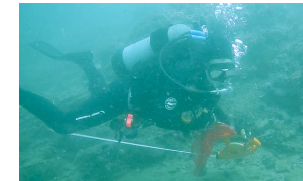
## Introduction

- Marine species are shifting their biogeographic ranges poleward<sup>1</sup>.
- A mechanism driving the shift may be transport of marine larvae up coasts by poleward ocean currents driven by El Niño Southern Oscillation events (hereafter El Niño)<sup>2</sup>.
- We explore this mechanism with a case study of Kellet's Whelk (*Kelletia kelletii*), a marine gastropod that has recently expanded its biogeographic range up the California coast<sup>3,4</sup>.
- Hypothesis:** El Niño drives recruitment of Kellet's whelk in the species' expanded range.
- Approach:** Compare the size frequency distribution of Kellet's whelk populations between the species' expanded and historic range before, during, and after the 2015-16 El Niño.
- Prediction:** Strong recruitment of young-of-year Kellet's whelk in the species' expanded range immediately following the El Niño, and no or less recruitment following the non-El Niño periods.
- Significance:** Kellet's whelk is a significant predator in kelp forests and emerging fisheries species. Also, El Niño is predicted to become more frequent and intense with climate change<sup>2</sup>. Thus study of Kellet's whelk is of current and future ecological and socioeconomic value.



## Methods

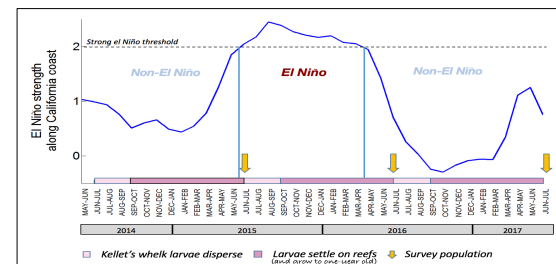
- We conducted fixed-width transect surveys of Kellet's whelk populations at 28 sub-tidal reefs across the species' historic and expanded range before, during, and after the El Niño (summer 2015, 2016 and 2017).
- We assessed the size-frequency distribution and density of Kellet's whelk populations at each site and in each year, with particular focus on detecting young-of-year recruits.



**Figure 1.** Size frequency distribution of whelk populations across sites and in the summers of 2015, 2016 and 2017. Summer 2016 directly follows the 2015-16 El Niño and thus is the year predicted to show strong recruitment of young-of-year whelks. Sites organized by GPS location (top to bottom is North to South).

## Results

- In the expanded range, the size-frequency distribution was not significantly different between 2015 (a warm, non-El Niño) and 2016 (non-El Niño) ( $p = 0.16$ ) – both showed evidence of recruitment of young-of-year whelks. However, there was a significant difference in the magnitude of recruitment ( $p < 0.001$ ).
- In the expanded range, the size-frequency distribution was significantly different between 2016 (El Niño) and 2017 (non-El Niño) years ( $p < 0.001$ ) – only 2016 showed evidence of recruitment of young-of-year whelks (2017 merely showed the aging of those whelks into 2-year olds).
- In the historic range, the size-frequency distribution whelks did not vary significantly among years ( $p = 0.8604$ ).



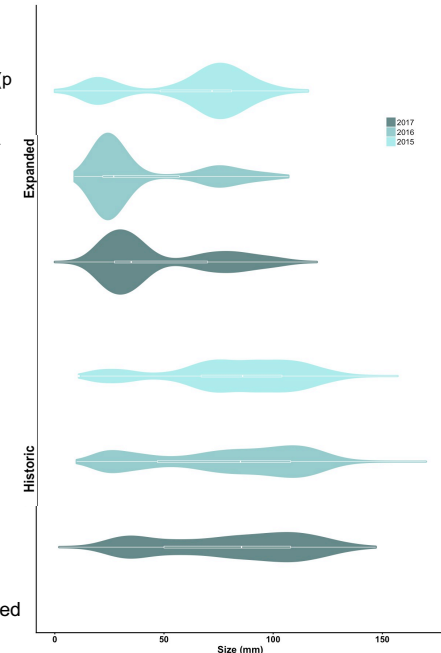
**Figure 2.** El Niño strength progression from 2015-2017 within our study domain (CA), calculated using the Multivariate ENSO Index provided by NOAA<sup>5</sup>.

## Discussion

Strong recruitment of young-of-year Kellet's whelk in the species' expanded range immediately following the El Niño, and no or less recruitment following the non-El Niño periods, supports our hypothesis that El Niño drives recruitment of Kellet's whelk in the species' expanded range.

Moderate recruitment in 2015 following the atypically warm non-El Niño period, strong recruitment in 2016 following the warm strong El Niño, and weak recruitment in 2017 following the cooler non-El Niño period, collectively implicate oceanographic currents, not just temperature, associated with El Niño in driving poleward range expansion of marine organisms.

Assignment of recruits to their natal populations (e.g., using genetics and microchemistry) would help determine if El Niño oceanographic conditions are indeed transporting larvae up the coast versus simply enhancing local recruitment in the expanded range.



**Figure 3.** Violin plots of size frequency distribution of all populations within each region and in each survey year.

## References

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