Changes in Modern Foraminiferal Assemblages Associated with Recent Northeast Pacific Marine Heatwaves

M. Kelsey Lane[1], Jennifer S. Fehrenbacher[1], Jennifer L. Fisher[2], Melanie R. Fewings[1], Byron C. Crump[1], Craig M. Risien[1]

[1] College of Earth, Ocean & Atmospheric Sciences, Oregon State University [2] Cooperative Institute for Marine Ecosystem and Resources Studies, Oregon State University

Introduction

- Marine heatwaves (MHWs) are prolonged warm water events with impacts on the marine ecosystem (Peterson et al., 2017).
- Planktic foraminifera are shelled microzooplankton frequently used for paleoclimate research (Fig. 1). Different species have unique environmental affinities and can be grouped into bioprovinces (Kucera et al., 2007).
- In this study, we identified and counted planktic foraminifera from a long-term time series to assess foraminiferal abundances and community composition from annual fall and spring research cruises and compared to environmental data.

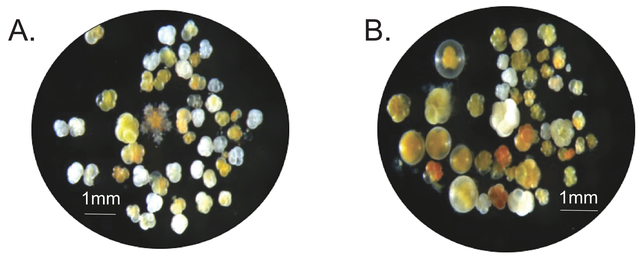

Fig. 1: Examples of representative foraminifera assemblages. A: colder water species and B: warmer water species collected during a MHW.

Research Question: How do marine heatwaves influence foraminifera communities across seasons in the California Current?

Methods

- Plankton tow samples and environmental data were collected from the Newport Hydrographic (NH) Line (Fig. 2), a long-term monitoring transect in the Northeast Pacific.
- Foraminifera were picked out of net tow contents, identified to species, & normalized by tow volume (Lane et al., 2023).
- We used multivariate analysis to determine how the foraminifera community data varied between seasons with and without a MHW and other environmental variables. Data was square-root transformed and visualized using a Principal Coordinates Analysis (PCoA) on a Bray-Curtis similarity matrix.

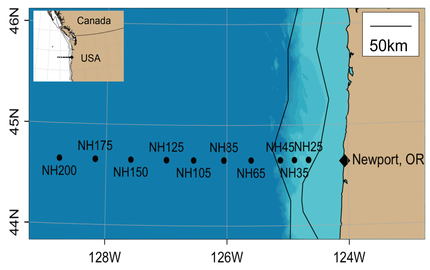

Fig. 2: Map of the NH Line. Station names denote distance offshore in nautical miles offshore. Not all stations were sampled every year and season.

The Newport Hydrographic Line experienced marine heatwaves in2014-2016 and in the fall of 2019 (Fig. 5).

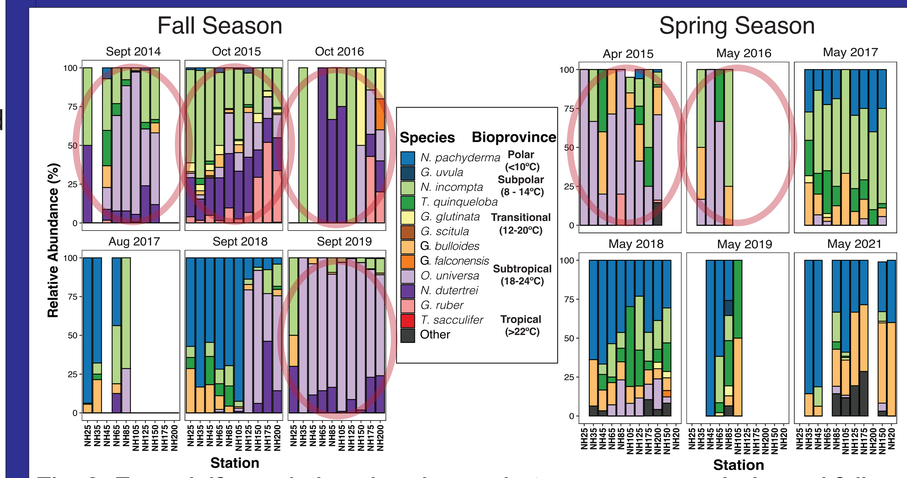

Fig. 3. Foraminifera relative abundances between seasons. A. Annual fall cruises. B. Annual spring cruises. Seasons with a MHW present are circled in red. Species colored according to bioprovince (Kucera et al., 2007).

Results

- During MHWs, subtropical and transitional species were dominant across the transect in the fall and spring seasons (Fig. 3).
- During non-MHWs, polar to transitional species were common closer to the coast in the fall and across the transect during the spring season. Subtropical species were found offshore during non-MHW fall seasons (Fig. 3).
- The foraminifera community varied significantly different between seasons and with the presence of a MHW (~beta diversity or species turnover, p<0.05, PERMDISP, Fig. 4).

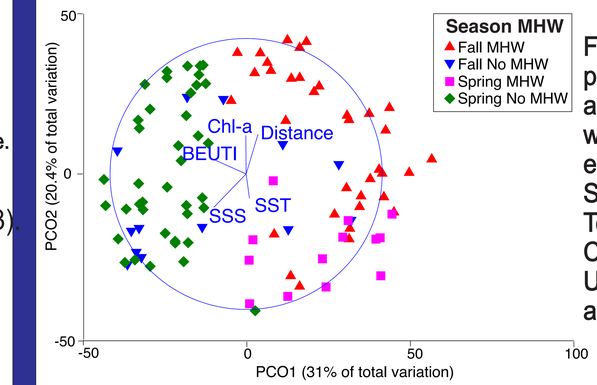

Fig. 4: Foraminiferal assemblage patterns between seasons with and without MHWs, visualized with a PCOA plot. Significant environmental variables (Sea Surface Salinity, Sea Surface Temperature, Distance offshore, Chl-a, and Biologically Effective Upwelling Index) are overlaid as vectors (Pearson correlation).

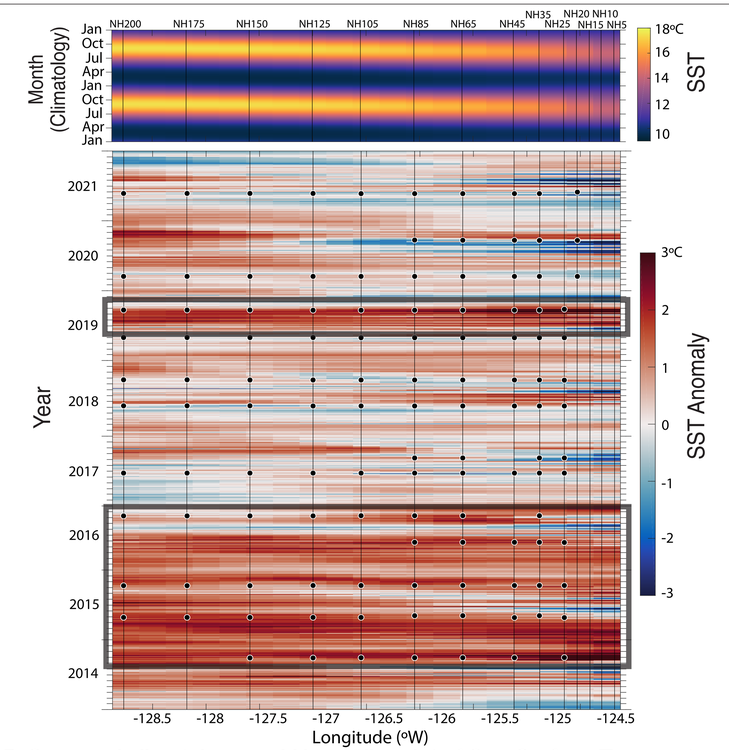

Fig. 5. Seasonal climatology and Hovmöller plot of Sea Surface Temperature (SST) anomalies along the NH Line. Upper panel: The 39-year (1982-2020) seasonal climatology is shown, repeated twice for clarity (from OISST v2.1). In the lower panel, SST anomalies from 2010-2019 are shown relative to the 39-year climatology. Vertical lines show the NH Line stations. The date and location of each sample is indicated with a black circle. MHWs are bound in black.

Conclusions

- Environmental factors like temperature, salinity, upwelling intensity and productivity influence foraminifera community patterns.
- Marine heatwaves impact the typical seasonal patterns of the foraminifera community in the Northeast Pacific.
- Foraminifera assemblages reflect extratropical warming on subseasonal to interannual time scales, which influences typical seasonal patterns, and could inform paleoclimate research about past MHW events.

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