EPOC-Sponsored Virtual Roundtable
"Current Events"
September 17th, 2020

Bright Lights in the Big Bight: How an historic red tide turned deadly
Clarissa Anderson, Scripps Institution of Oceanography

In late March 2020, a robotic microscope deployed on a mooring that sits on the continental shelf offshore of Del Mar captured images of the early stages of a spring phytoplankton bloom. It was a fairly typical mixture of microalgae for this time of year when we expect upwelling of deeper water to deliver nutrients to the well-lit surface layer. The community was primarily comprised of chain-forming diatoms like *Chaetoceros* spp. and *Pseudo-nitzschia* spp., and to a lesser extent, armored dinoflagellates such as *Gonyaulax* spp. and *Lingulodinium polyedra* (Fig. 6). By April, *L. polyedra* had taken over and was creating spectacular bioluminescence displays for weeks at southern California beaches. The massive "red tide" ultimately spanned from Anacapa Is. to southern Baja CA. This roundtable discussion will delve into the difficulties sampling such an extreme event during the time of COVID-19, the characteristics of the bloom and environmental forcing that made it the largest and longest on known record, and the outcome that has essentially re-branded *L. polyedra* a high-profile harmful algal bloom species for Southern California.

Quantifying resilience of fished populations to climate disturbances
Caren Barceló, UC Davis

Understanding the resilience of an ecosystem to disturbance is a central tenet of applied ecology. Episodic disturbances (e.g. multi-year marine heatwaves) can cause transient shifts in the dynamics of fished populations, and quantifying the expected durations of and recoveries from those effects are a challenge. Generally, two characteristics of resilience are of interest: the resistance to a disturbance, and the rate of recovery from a disturbance. Here we use age-structured models to characterize the impact of a single, pulsed disturbance on marine fish populations. Specifically, we address three main questions about population-level resilience: 1) what aspects of a species' life history influence recovery time and resistance to a single pulse disturbance, 2) how do harvesting marine protected areas (MPAs) change those responses, and 3) how does the duration of the disturbance affect a population's response to it? We found that the natural mortality rate is the primary determinant of the recovery time; longer-lived, lower-mortality species recover more slowly. High harvest rates both reduce the initial resistance to disturbance and prolong the recovery time. Together these results are important steps in setting expectations of how a disturbance pulse of differing magnitudes and duration can impact fished populations, particularly as the frequency and intensity of such disturbances are increasing with climate change.

Predictability of Northeast Pacific Marine Heatwaves
Antonietta Capotondi, CIRES/NOAA Physical Sciences Laboratory

Starting in 2013, the northeast Pacific has exhibited a series of extreme sea surface temperature (SST) conditions including: the "Blob" in the winter of 2013-14 which evolved into the "Arc" pattern along the US West Coast from late 2014 through the winter of 2015/16 with variations in the local details of warming; the "Blob 2.0" in the summer of 2019 and the recent warming in the spring/early summer of 2020. Such frequent occurrence of extreme warming events suggests persistence of climate forcing of those conditions, and opens the question of the leading driving factors of those conditions and whether they can be associated with some degree of predictability. Operational forecast systems tend to underestimate the magnitude of these events, suggesting that their predictability may be low. However, model errors could also play a role. Here, we use Linear Inverse Models (LIM), i.e. empirical models constructed from observations, to identify key climate feedbacks that may provide a source of predictability for extreme SST conditions. The performance of this approach, and the lessons learnt are discussed.

Predicting domoic acid contamination in California fisheries to guide dynamic ocean management
Chris Free, UC Santa Barbara

Harmful algal blooms produce toxins that accumulate in the tissue of seafood species and represent an increasing threat to seafood harvesters and consumers. Developing tools for predicting toxin contamination is critical to designing dynamic management strategies for mitigating risk to consumers while also minimizing impacts on harvesters. We develop machine learning models for predicting daily coastwide domoic acid contamination in seven harvested marine invertebrates in California. Contamination in four wild capture species (Dungeness crab, rock crab, spiny lobster, razor clam) frequently exceeded management action thresholds. Models developed for these species were good predictors of contamination risk and hindcast high rates of contamination in historical catch. On the other hand, contamination in two aquaculture species (Pacific oyster, bay mussel) rarely exceeded management action thresholds and new data streams will be necessary to develop models for predicting contamination and guiding management for these species. We use our models to assess the appropriate spatial-temporal scales for toxin monitoring programs and dynamic fishery closures.

Can we use sea surface temperature as a proxy for winter-time near-bottom temperature along the west coast of Canada?
Charles Hannah, Fisheries and Oceans Canada

Temperature time series from mooring instrumentation along the west coast of Canada shows that the wind driven mixing in the fall and winter is a dominant feature of the annual cycle of sub-surface temperature on the shelf. For example, at 50 m depth the temperature maximum occurs in late November or early December and the temperature minimum occurs sometime between January and April. In January and February near isothermal temperatures extend down to 75 m or 100 m (or even deeper) while a weak salinity stratification is maintained. In this presentation we explore whether 1) satellite sea surface temperature is a reasonable proxy for the observed temperatures between 15 m and 150 m in winter; and 2) can long time series of coastal sea surface temperature be used as a proxy to examine trends and decadal variability in near-bottom temperature along the British Columbia continental shelf?

Long-term, in situ estimates of net primary production in the Subpolar Northeastern Pacific and the impact of recent marine heatwaves
Jacqueline Long, Monterey Bay Aquarium Research Institute
with Andrea Fassbender, Yibin Huang, Mariana Bif, and Margaret L. Estapa

Ocean net primary production (NPP) is equal to gross photosynthesis minus the respiration by primary producers, setting the maximum amount of carbon available for export from sunlit surface waters to depth where it can be sequestered from the atmosphere. This important piece of the global carbon cycle puzzle suffers from limited in situ, discrete observations, and while satellite estimates have been made, winter observations are often absent due to heavy cloud cover and glint in high-latitude regions. Building from prior work in the Subtropical North Atlantic (Estapa et al., 2019) we apply the Carbon-based Production Model (CbPM) to estimate NPP using depth-resolved observations from biogeochemical profiling floats in the Subarctic Northeastern Pacific Ocean, near Ocean Station Papa (OSP). We present the first multi-year record (2010–present) of NPP at a depth resolution of ~5 m and temporal resolution of ~10 days (float profiling frequency). Comparisons of depth integrated NPP derived from upper water column satellite observations and depth-resolved float observations indicate relatively good agreement, however climatological discrepancies exist. Float observations of nitrate, temperature, backscatter, and net community production (gross photosynthesis minus community respiration) provide context for interpreting the seasonal patterns and climatological divergences in NPP. Comparisons between two recent marine heat waves (2013–2015 and 2018–2020) and normal years are made and related to findings of reduced NCP during 2013–2015 (Bif et al., 2019; Yang et al., 2017). By considering both NPP and NCP, we evaluate how shifts in ecosystem functionality may be responsible for carbon cycle changes during these warm events.

Is the Northeast Pacific transitioning from a HNLC to a spring bloom system?: anomalous biogeochemical observations in 2019
Angelica Peña, Fisheries and Oceans Canada

For the first time in 60 years of observations, in 2019, the summer mixed layer nitrate was completely depleted at Ocean Station Papa (OSP) and other offshore stations along Line P. Phytoplankton biomass was also unusually high, with diatoms dominating phytoplankton biomass at several open-ocean stations. These observations point to the Northeast Pacific behaving more like a spring bloom system than a High Nutrient Low Chlorophyll (HNLC) region in 2019. Analysis of Argo float data from near OSP suggests that there was less winter mixing in 2019, and thus less vertical nutrient inputs, likely related to the continuing marine heatwave conditions that were present throughout much of 2019. However, while winter macro-nutrients were on the low end of the previously observed values, they were not anomalous like the summer values. This suggests that while enhanced winter stratification contributes to lower nutrients, the complete drawdown in summer is likely of biological origin. The lack of coastal eddy presence in satellite sea surface height anomaly data or of a reported volcanic eruption in the area suggests that iron input to the euphotic zone was not responsible for the increase in phytoplankton biomass and diatom abundance but that perhaps enhanced mixed layer iron recycling or more efficient use of the available iron resulted in this anomalous depletion of nutrients.

Evolution of conditions prior to and during the SoCal 2020 HAB development

Uwe Send, Scripps Institution of Oceanography
with C. Lowcher, J. Sevadjian, A. Barton, H. Sosik, D. Lucas, R. Kempster, A. Feit

Moored time series from three locations in the San Diego region are available to observe the temperature, stratification, currents, oxygen, chlorophyll and nitrate concentrations, before, during, and after the red tide in April/May 2020. There is a clear alternation of upwelling/relaxation events during this timeframe. During the second upwelling event, the stratification increases due to rainfall, and chl increases. An IFCB on the mooring registered strongly enhanced *Lingulodinium* when the upwelling relaxes again with strong surface stratification present. We will discuss some of the conditions that may have contributed to the appearance of the red tide.