EEB313 – Mid-Project Update - **Naveen David and Silas Peters**

We are aiming to answer the question ‘does ocean pH (measured via pCO_2) influence abundance (examined through growth rate) and/or diversity of plankton in the north Atlantic’. Our first hypothesis is that pH affects the diversity of plankton; an increase in pCO_2 causes a decrease in diversity as vulnerable taxa decrease in abundance. If possible, we’ll also test if pH affects the abundance of vulnerable taxa. For this, we can predict that increasing pCO2 decreases the growth rate of vulnerable plankton and increases resistant plankton’s growth rate.

The plankton data is from a continuous long-term sampling project that took place over the past 90 years in the north Atlantic (N: 64.907 E: -23.092 S: 36.28 W: -74.743; Helaouet et al., 2024). Recorders are towed behind ships and plankton experts ID them to various taxonomic levels (Richardson et al., 2006). We used data on the sampling year and plankton abundance, which was organized by taxa. We filtered the data to 1981-2018 to overlap with the pCO2 data. To calculate growth rate, we took the difference in abundance between years, divided by the starting abundance and multiplied by 100. We pursued diversity indices to examine effects of pCO_2 on plankton communities, as grouping taxa by vulnerability would be tedious and potentially inaccurate. We then calculated the Shannon’s Diversity Index using the package ‘vegan’ (Oksanen et al., 2024). Higher values mean higher diversity (Nolan & Callahan, 2006). Over time, there is a slight increase in diversity. However, some taxa were added after 1981, which we may exclude if this affects the diversity index.

The water quality data is from a NOAA database of 14.2 million observations collected from a series of different research expeditions from 1957-2019 (Takahashi, Sutherland & Kozyr, 2019). To ensure consistency, NOAA quality-controlled the data based on a series of parameters, including the reliability of CO_2 calibrations and the data’s internal consistency. For this project we used location data, temperature, and pCO2. First, we filtered it to spatially and temporally overlap with the plankton data, including only a continuous stretch where data was collected (1981-2019). We randomly sampled 5 observations per year to avoid bias; some years had 5 samples, while others had 150000. We then calculated temperature and pCO_2 averages. Initial analysis shows a clear trend of pCO_2 increasing over time.

Moving forward, now that our data is clean and our metrics are calculated, we will use a time series analysis to examine the effect of pCO_2 on plankton (Righetti, 2022). We will follow steps outlined by Righetti (2022), first turning our data frame into a time series object using *ts_format*(). We will then plot the time series to understand the general trend. We can then decompose our time series into the main components (observed, trend, seasonal, random), which will help us understand where variation in our data may be coming from. Depending on what we analyze, we can also adjust our data for certain factors. Most importantly, we will cross-correlate the pCO_2 data (X) and diversity index data (Y). We will also be able to forecast the values into the future, using the package ‘forecast’ with ARIMA modelling (Righetti, 2022).

References

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