Motivations
The scarcity of long-term, highly resolved, precisely dated marine records makes it difficult to reconstruct and model Atlantic Meridional Overturning Circulation (AMOC) strength, a necessity for understanding both the natural variability of this system and the exact mechanisms by which the AMOC regulates North Atlantic and global climates. Recent modeling studies suggest that the Gulf of Maine, situated in the western North Atlantic, may be an ideal location for AMOC strength reconstructions due to the influence that the AMOC has on hydrographic properties in this region.

Introduction and Methods
Study Site: The Gulf of Maine

The Gulf of Maine's hydrographic properties are influenced by warm slope waters brought up from the tropics by the Gulf Stream and colder slope waters brought down from the Labrador Sea by the Labrador Current. Recent research suggests that the AMOC strength has decreased (increased) bringing warmer (colder) water closer to (farther away) from the Gulf of Maine. Therefore, Gulf of Maine seawater temperatures are likely inversely related to AMOC strength and reconstructions of these seawater temperatures in the Gulf of Maine have the potential to lead to valuable insights into past AMOC behavior.

Hydrographic Reconstruction

To reconstruct Gulf of Maine hydrographic conditions, we used Arctica islandica shells, which:
• Precipitate in oxygen isotopic equilibrium with seawater, enabling seawater temperature reconstructions.
• Deposit annual increments, enabling the collection of precisely dated and annually resolved data.

A master chronology of fossil and live-caught shells from near Seguin Island, western Gulf of Maine, was built using crossdating techniques. Shells were sampled using a Merchantek micromill and oxygen isotopes were analyzed using a ThermoFinnigan MAT Delta Plus XL mass spectrometer coupled with a GasBench II.

Results

Figure 1. Map of the correlation (r, shaded regions indicate correlations with p<0.05) between modeled AMOC (EMCWF S3) and sea surface temperature (SSTs), HadISST in the North Atlantic. The orange box outlines the Gulf of Maine. The orange marker denotes the study site for this research. Major ocean currents in the western North Atlantic, the Labrador Current (yellow) and the Gulf Stream (red), are marked.

Figure 2. An A. islandica shell (A) and a shell cross-section being milled for isotope analysis (B).

Discussion and Future Work

Oxygen isotopes measured in Arctica islandica shells show a strong correlation with the nearby (~17 km) instrumental record of SSTs from Boothbay Harbor, Maine (Figure 5), indicating that these data are a valid proxy for Gulf of Maine SSTs.

Based on previous modeling work that suggests that Gulf of Maine SSTs are influenced by AMOC strength, we would expect our SST proxy record to represent a reconstruction of AMOC variability.

The δ18O record has strong but variable correlations with modeled AMOC strength (EMCWF S3) and the instrumental record of Florida Current strength (a component of surface AMOC) at various lags and times of the year (Table 1). Further investigation into the appropriate model for AMOC strength is needed to more comprehensively analyze these complex relationships.

While the Gulf of Maine oxygen isotope record is a promising proxy for AMOC strength variability over the last several centuries, additional modeling work is necessary in order to fully assess this proxy and utilize it to reconstruct (components of?) AMOC strength.