Background:

Despite its polar conditions, the Arctic Chukchi Sea has been ranked one of the most productive seas in the world [1,2]. Of which, at least 10% has been attributed to the production of sea ice algae [2], which is a much higher proportion than any other shelf seas in the Arctic, with the exception of the Barren Sea [3]. In the Chukchi Sea, sea ice algae production is directly transferred to the macrobenthic faunal community with little being consumed before reaching the sea bed [4]. The benthic production, then, support the higher trophic organisms such as Pacific walrus, grey whales and bearded seals [5].

Given the importance of sea ice algae and sea ice coverage in general, it is particularly worrisome that unprecedented changes in sea ice extent and thickness have been observed in recent decades [6,7]. For example, in 2007, the sea ice extent was 23% below previous low. There is a high probability of a 40% reduction of summer sea ice extent in the Arctic by the year 2050 [8]. They are predicted to affect marine primary production in general [6]. However, little is known of how the benthic macrofauna responded to historic changes in sea ice cover and thus, prediction models lack the capacity to be thoroughly verified. Fortunately, bivalve shell growth has been shown to reflect changes in regional environmental parameters such as temperature and precipitation as well as food availability [9]. We could reconstruct past climatic events from the said records to not only study the effect of climate change, sea ice coverage in particular, but also to project future variations accordingly to climate model projection.

Methods:

For this project, I collected more than 2,000 shells of multiple bivalve species from the central and northern Chukchi Sea (Figure 1) in summer 2015 on a research vessel funded by USGS. These regions contain several bivalve hotspots and attract a large number of Pacific walrus as well as other large consumers [5]. The shells will be processed to extract their growth patterns at the University of Texas – Marine Science Institute (UT-MSI), Port Aransas, Texas. The soft tissues would also be analyzed for stable isotopes. The result of those analyses would be used to correlate with the sea ice coverage records in the same regions with the number of years that the bivalve records cover.
ArcGIS would then be utilized first to present the locations where the samples were collected with superimposed population component, second to present a synopsis of changes in sea ice cover through time and third to interpolate bivalve growth rates and stable isotope values throughout the years.

Objectives for ArcGIS:

- To create a high definition map of central and northern regions of Chukchi Sea which would be used as based map for all figures
- To create a time series presentation of sea ice coverage through time
- To create a spatial interpolation map of stable isotope values of the bivalve I collected
- To create a spatial interpolation map of growth rates of the bivalve I collected

Execution plan:

To create a high definition map of central and northern regions of the Chukchi sea, I plan to use the topographic basemap available to ArcGIS 10.3.1. For the coastline of Alaska, I plan to ask for permission to use the high definition coastline shape files from USGS. If said files are not available, I would use the coastline data available to ArcGIS 10.3.1.

I plan to extract the satellite sea ice concentration data from datasets available from the National Snow and Ice Data Center (nsidc.org/data/nsidc-0051) [10]. As I have not had the age structure from my own samples, for this particular C E 394K project, I would restrict the dataset to the years between 2000 and 2015. The time series display created by ArcGIS would be used in my C E 394K oral presentation and for other occasions such as seminars and conferences. I also plan to create the time series display in ArcGIS by following the method presented by Denniston [11]. The ice coverage map of 2007, 2010 and 2015 would be included in C E 394K final report and my thesis to show the significant changes throughout the years (from very low coverage to high coverage and back to low again).

Several interpolation methods (spline, natural neighbor, kriging, and inverse distance weighting) will be tested to see which one is appropriate for growth rates and which one is appropriate for stable isotopes. Because it is unlikely that I would have my stable isotope data ready within the Fall 2015 semester, for C E 394K final report, I would be using values from the Pacific Marine Arctic Regional Synthesis (pacMARS) project, comprised from various studies by Dr. Kenneth Dunton (UT-MSI) as a demonstration.

All layers would be projected in the GCS_WGS_1984 Geographic coordinate system using the D_WGS_1984 datum

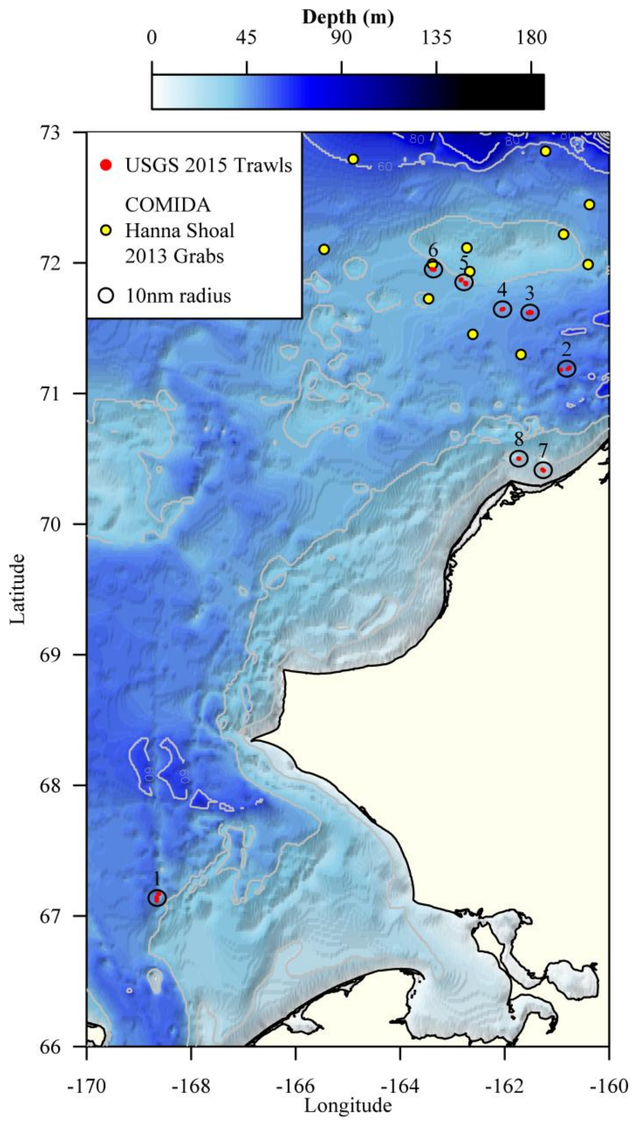

Figure 1: Locations of bivalve collection site in summer 2015. The region below 69^{o}N latitude is central Chukchi Sea and the region above 69^{o}N latitude is northern Chukchi Sea.

Reference list:

1 Hill, V. & Cota, G. Spatial patterns of primary production on the shelf, slope and basin of the Western Arctic in 2002. *Deep Sea Res. (II Top. Stud. Oceanogr.)* **52**, 3344 - 3354, doi:10.1016/j.dsr2.2005.10.001 (2005).

2 Gosselin, M., Levasseur, M., Wheeler, P. A., Horner, R. A. & Booth, B. C. New measurements of phytoplankton and ice algal production in the Arctic Ocean *Deep Sea Res. (II Top. Stud. Oceanogr.)* **44**, 1623 - 1644 (1997).

3 Sakshaug, E. in *The Organic Carbon Cycle in the Arctic Ocean* (eds R. Stein & R.W. Macdonald) Ch. 3, 57 - 82 (Springer, 2004).

4 Dunton, K. H., Saupe, S. M., Golikov, A. N., Schell, D. M. & Schonberg, S. V. Trophic relationships and isotopic gradients among arctic and subarctic marine fauna. *Mar. Ecol. Prog. Ser.* **56**, 89 - 97 (1989).

5 Grebmeier, J. M., Cooper, L. W., Feder, H. M. & Sirenko, B. I. Ecosystem dynamics of the Pacific-influenced Northern Bering and Chukchi Seas in the Amerasian Arctic. *Prog. Oceanogr.* **71**, 331 - 361 (2006).

6 Palmer, M. A., Saenz, B. T. & Arrigo, K. R. Impacts of sea ice retreat, thinning, and melt-pond proliferation on the summer phytoplankton bloom in the Chukchi Sea, Arctic Ocean. *Deep Sea Res. (II Top. Stud. Oceanogr.)* **105**, 85 - 104 (2014).

7 Zhang, J. *et al.* The influence ofsea ice and snow cover and nutrient availability on the formation of massive under-ice phytoplankton blooms in the ChukchiSea. *Deep Sea Res. (II Top. Stud. Oceanogr.)* (2015).

8 Overland, J. E. & Wang, M. Future regional Arctic sea ice declines. *Geophys. Res. Lett.* **34**, 1 - 7 (2007).

9 Carroll, M. L. *et al.* in *SPE International Conference on Health, Safety, and Environment in Oil and Gas Exploration and Production* (Nice, France, 2008).

10 Johannessen, O. M., Shalina, E. V. & Miles, M. W. Satellite evidence for an Arctic sea ice cover in transformation. *Science* **286**, 1937 - 1939 (1999).

11 Denniston, R. in *Data and Visualization Services Blog* (Duke University, 2011).