Alexandrium in the Arctic: Are harmful algae spreading as the Arctic warms?

Sveinn V. Einarsson[1], Kate Lowry[2,3], Carin Ashjian[3], Robert Pickart[3], P. Dreux Chappell[1]

1. Old Dominion University, Norfolk, VA 2. Science Philanthropic Alliance, Palo Alto, CA 3. Woods Hole Oceanographic Institution, Woods Hole, MA

Introduction

- *Alexandrium tamerense* is a well studied dinoflagellate known for its ability to produce the neurotoxin that causes paralytic shellfish poisoning (John et al. 2014).
- Until 1970 *A. tamerense* was only found in Europe, North America, and Japan but has been increasingly found all over the globe, and as a result toxic blooms have been increasing (Lilly et al. 2007).
- *Alexandrium* is characteristically found in temperate and subtropical regions (Lilly et al. 2007) and as the Arctic warms, there is considerable concern that it may be expanding into the Arctic.
- Warm Pacific water flows into the Alaskan Beaufort Sea from the Alaskan Coastal Current and is brought onto the Beaufort Sea shelf by the Shelfbreak Jet, shown in Figure 1 (Spall et al. 2008).
- Under certain wind conditions, the Shelfbreak Jet reverses resulting in upwelling delivering nutrient rich, cold water to the region. (Pickart et al. 2011).
- This study combined multiple methods to evaluate *Alexandrium* abundance in the Beaufort shelf region collected before, during, and after an upwelling event.

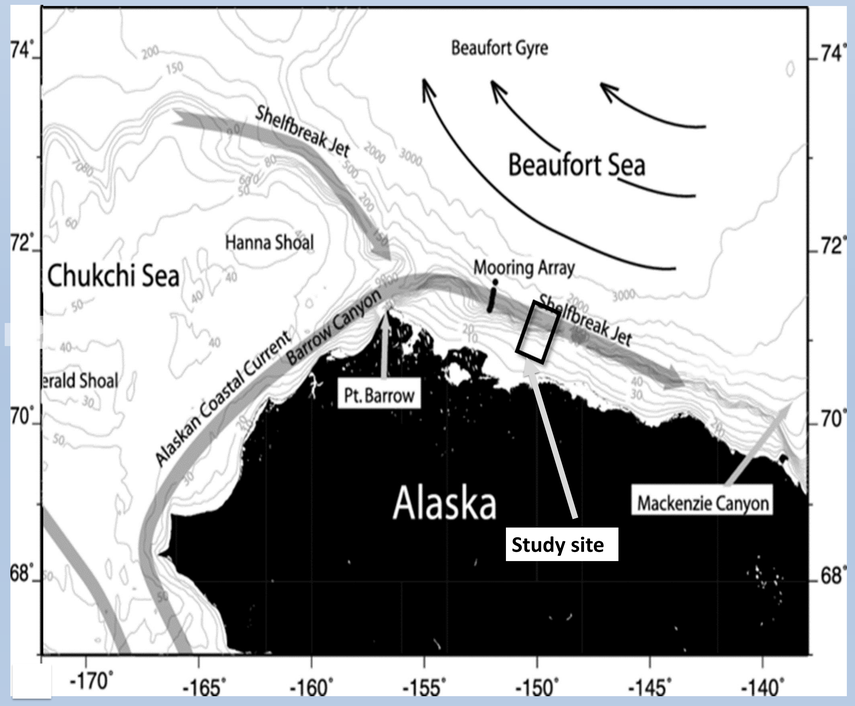

Figure 1 – Map showing Alaskan Coastal Current and Shelfbreak Jet that bring warm Pacific water to the Beaufort Sea Shelf (Pickart et al. 2011). The study site is displayed with a black rectangle.

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Results

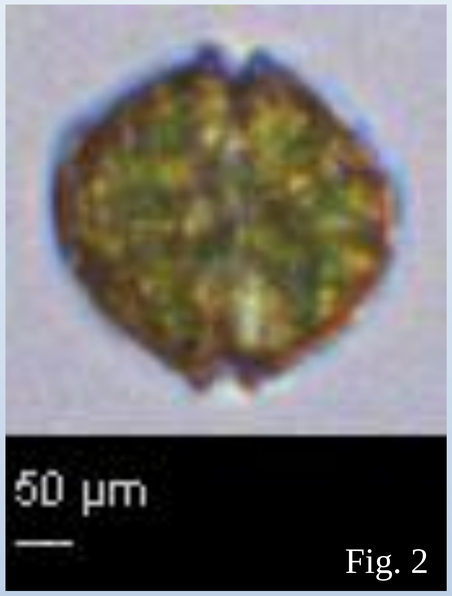
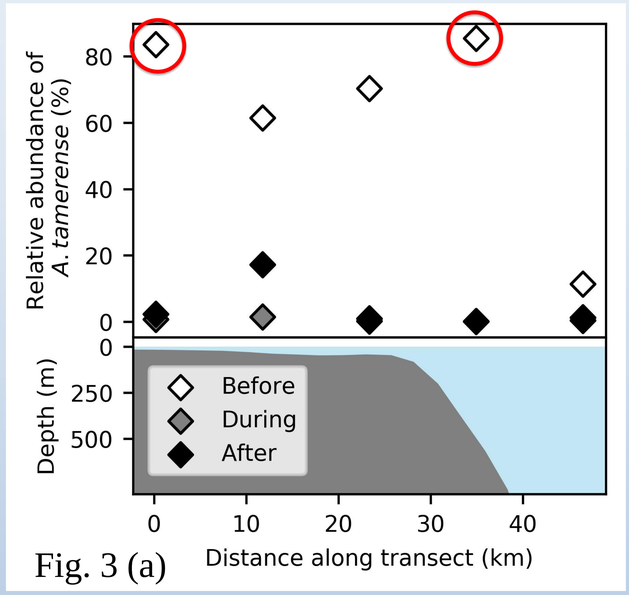


Figure 2 - FlowCam image of *Alexandrium* found before upwelling.



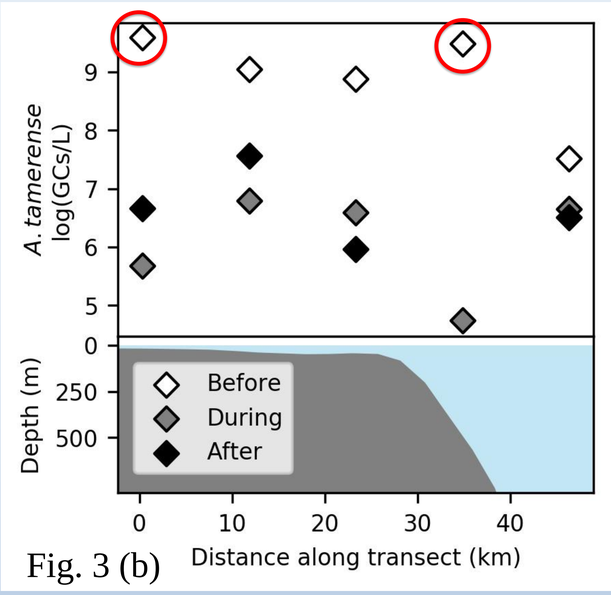


Figure 3 – (a) Relative abundance of *A. tamerense* 18S sequences as a proportion of total 18S phytoplankton sequences (dinoflagellates, diatoms, and haptophytes) (b) qPCR abundance of *A. tamerense*.

Discussion

- Here we have shown 3 methods of monitoring *Alexandrium:* FlowCam analysis, quantitative PCR, and relative abundance of 18S sequences. Each method showed an increased abundance before upwelling on the Beaufort Sea shelf and shelfbreak.
- It does seem that warm Pacific water is potentially bringing *Alexandrium* into the Arctic where it hasn't been found before.
- Curiously *Alexandrium* decreased dramatically during and after upwelling, which would be a source of nutrients that might otherwise be expected to increase abundance.
- A possible explanation is that the Shelfbreak Jet is known to reverse during upwelling winds (Pickart et al. 2011). Shutting down the import of warm Pacific water, and taking away the warmer water *Alexandrium* is found in.

Thoughts for the future

- Arctic is getting warmer (Liao et al. 2015) and sea ice is retreating more each year.
- Beaufort sea upwelling is strongest when there is less sea ice (Schulze and Pickart 2012) and the winds that drive the upwelling in the Beaufort Sea are becoming more frequent (Pickart et al. 2013).
- As the Arctic warms, Alexandrium needs to be monitored in this area due to its ability to produce neurotoxins that can accumulate in shellfish and fish, and as a result can effect humans, other mammals, and seabirds after consuming contaminated prey (Anderson et al. 2012).

Methods

- For FlowCAM (Fluid Imaging Technologies) imaging, samples were pre-filtered using 100 µm Nitex mesh and 5 mL of filtered sample were run at two different magnifications (100x and 40x) to assess the microplankton community.
- The V9 variable region of 18S rRNA was amplified from DNA extracted using the Dneasy kit (Qiagen) from 4L of filtered seawater using 1391F/EukBR primer pair (Stoeck et al. 2010) modified for Illumina sequencing and sequenced at the ODU MiSeq Sequencing facility. DNA sequences were analyzed using DADA2 (Callahan et al. 2016). Amplicon Sequence Variants identified using BLAST (Altschul et al. 1990.
- qPCR assay for *A. tamerense* followed Hosoi-Tanabe and Sako, 2005.

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Contact email:
- seina001@odu.edu