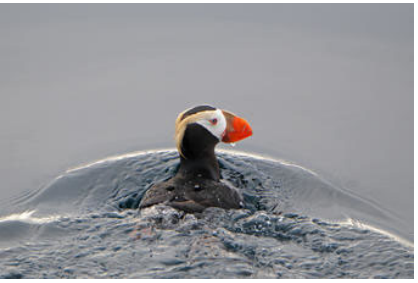
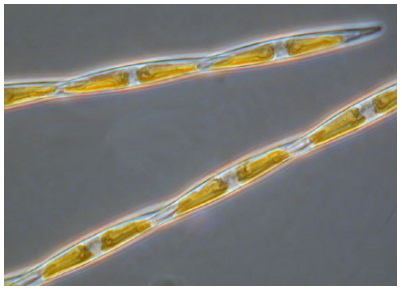
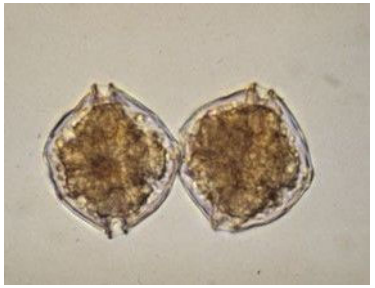
Harmful algal blooms in the Bering, Chukchi, and Beaufort Seas in 2018 and 2019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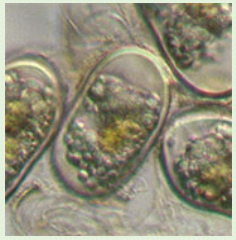
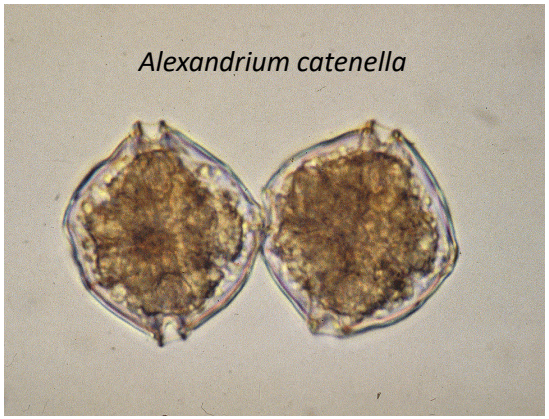
Overview

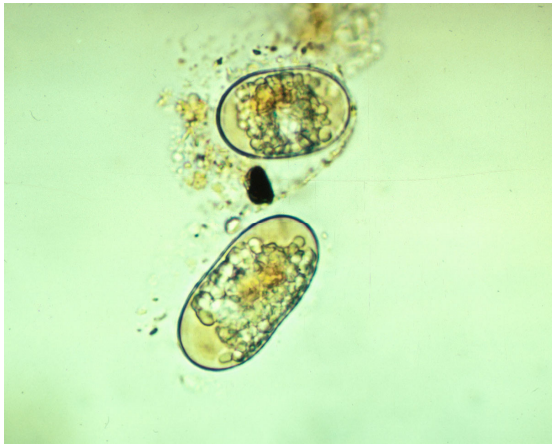
- Harmful algal blooms (HABs) are a global problem, increasing in frequency and geographic extent
- Negative impacts of HABs include public health threats, ecosystem damage, and economic loss
- Human poisoning syndromes from eating toxic shellfish (or fish):
  - Paralytic Shellfish Poisoning (PSP)
  - Neurotoxic Shellfish Poisoning (NSP)
  - Amnesic Shellfish Poisoning (ASP)
  - Diarrhetic Shellfish Poisoning (DSP)
  - Azaspiracid Shellfish Poisoning (AZP)
- Fish and wildlife mortalities – food web transfer
  - Domoic acid poisoning (DAP)

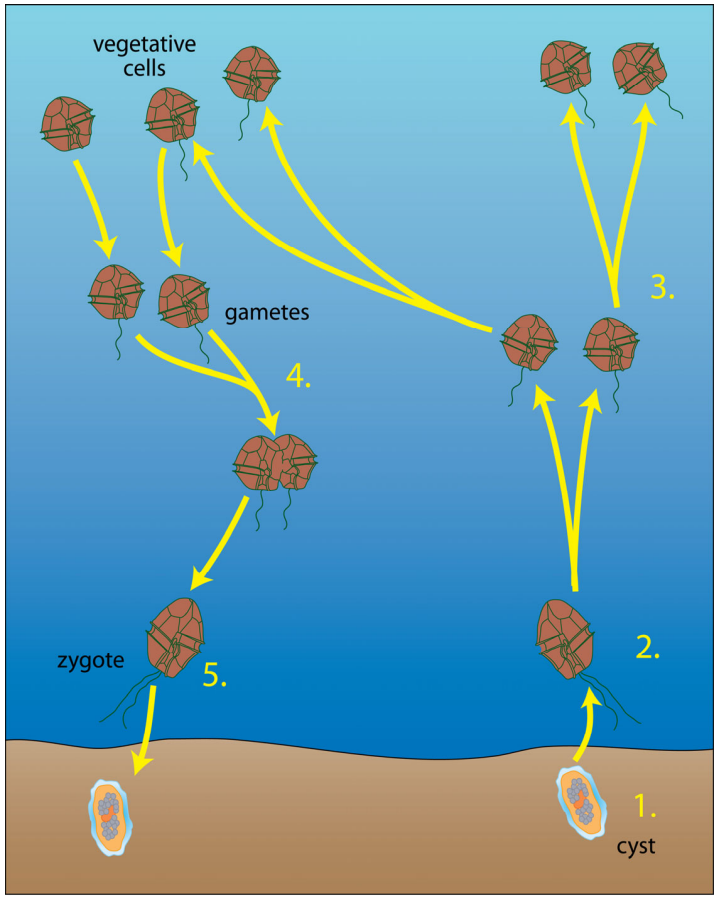


Project Overview

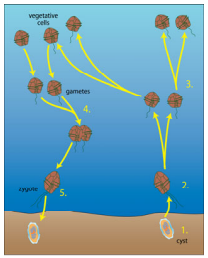
- **Recent studies have shown that multiple HAB toxins are present in the Arctic**
- **Warming ocean temperatures and decreasing ice cover will likely expand the spatial and temporal window of HABs in the Arctic.**
- **Human health and ecosystem impacts could be significant** in a region where routine monitoring programs for toxins in shellfish and fish do not exist and where there is no societal experience with algal toxins in the food web.
- **The goal of this program is to determine distribution, community structure, and dynamics of *Alexandrium catenella (*and *Pseudo-nitzschia)* in the Bering, Chukchi and Beaufort Seas.**
- Cruises: Healy 1801, 1803, 1901, (& 2001)


Alexandrium catenella

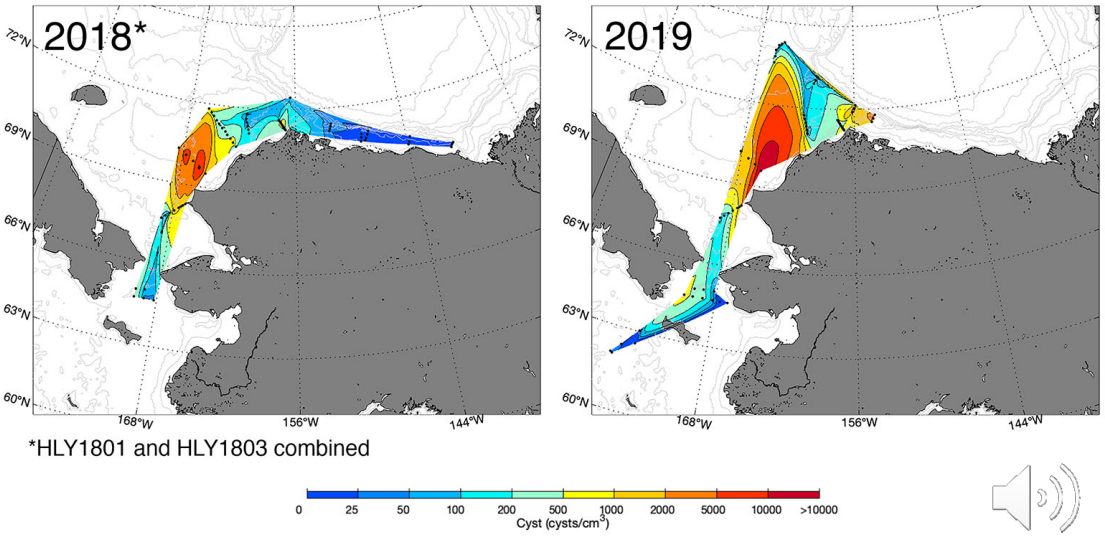



vegetative cells
gametes
4.
3.
zygote
5.
2.
1.
cyst

Alexandrium catenella cysts in bottom sediments (top cm)

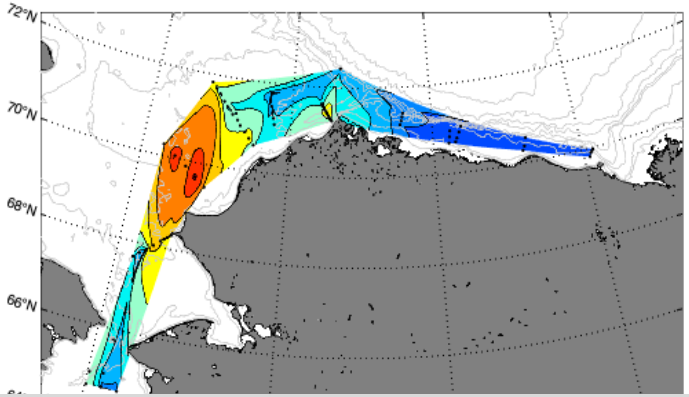


- **Massive *A. catenella* cyst bed** documented in Chukchi Sea in both 2018 and 2019
- This persistent feature extends at least 200 km offshore and up to 600 km alongshore.
- Cyst concentrations (**up to 17,000 per cm^{-3}**) are the highest ever reported for this species globally.
- Positive but low cyst concentrations in the Bering Strait and Beaufort Sea regions.
- **Second seedbed near Barrow Canyon,** has concentrations of ~14,000 cysts/cc.
- This secondary seedbed was not detected during 2018 sampling (region not sampled).

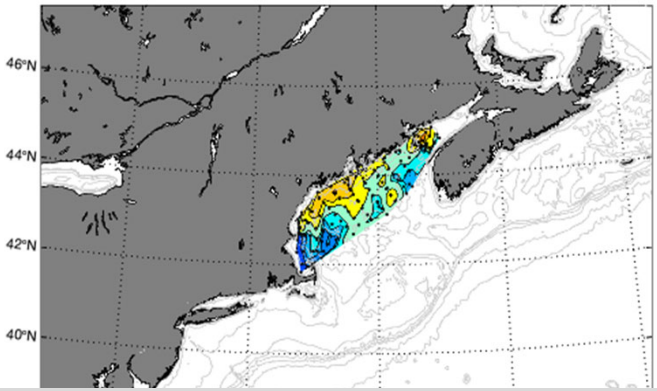


Cyst Seedbed Scale Comparison: Chukchi vs. Gulf of Maine

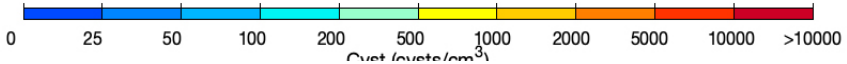
Alaskan Arctic 2018 Cyst Map



Gulf of Maine 2010 Cyst Map

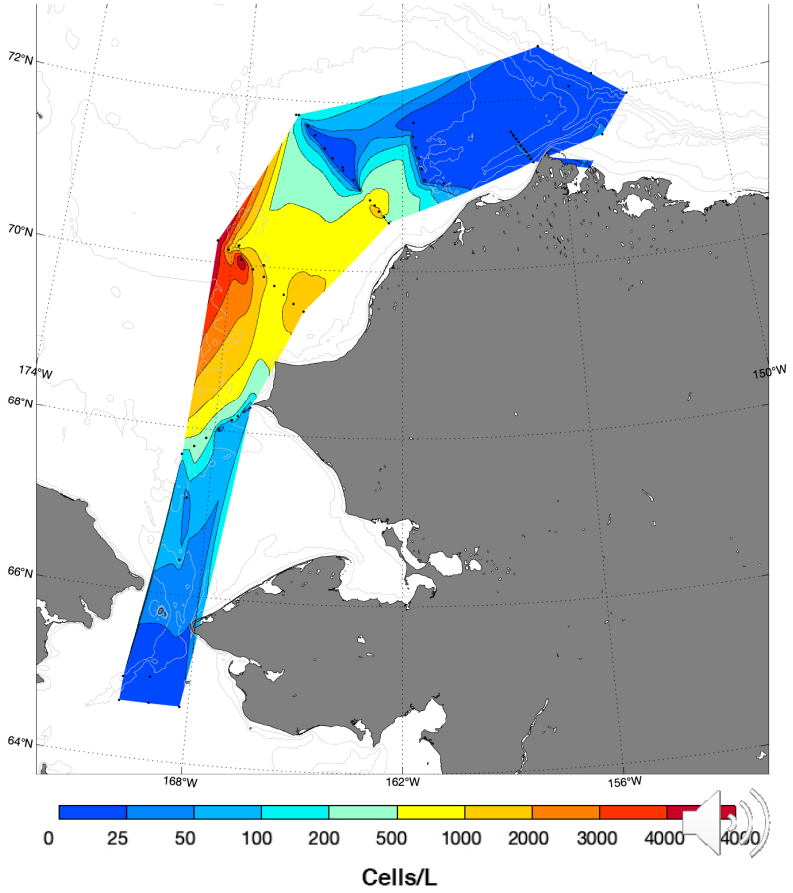


The Alaskan Arctic *Alexandrium catenella* cyst seedbed is ~5 X larger than the equivalent feature in the Gulf of Maine and contains ~6.4 X more cysts. For context, the Gulf of Maine cyst bed has supported large-scale, recurrent *Alexandrium* blooms for many decades.



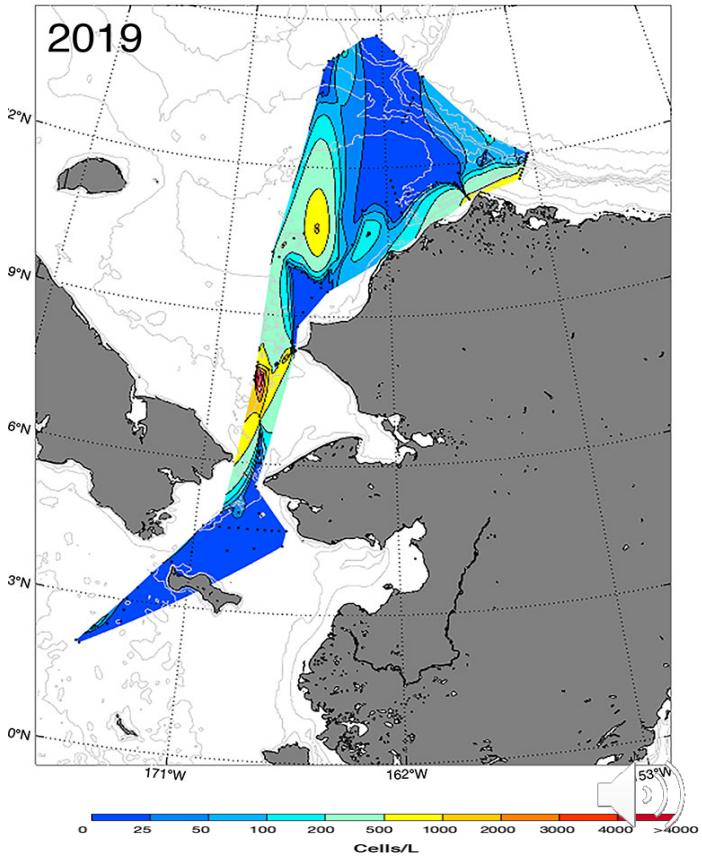
2018 - Healy 1801 Vegetative Cells

- **A large bloom of vegetative *A. catenella* cells was detected at high concentrations (max ~5,000 cells/L) in the Chukchi Sea during August 2018**
- **These concentrations are well above levels known to cause dangerous toxicity in other regions**
- **Positive correlation observed between cyst seedbed location and presence of planktonic cells**
- **Combined, cyst/cell counts and environmental data indicate that blooms in this region may be locally originating and self-seeding, and therefore likely to be recurrent events**



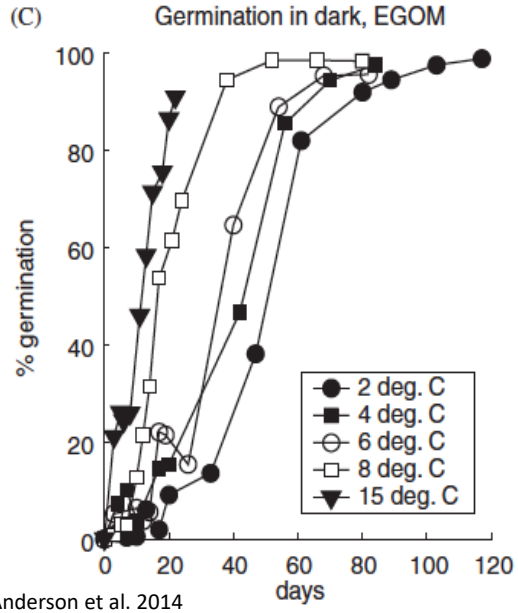
2019 – Healy 1901 Vegetative Cells

- Low densities of cells recorded in the Northern Bering Sea
- High density *A. catenella* bloom north of Bering Strait, maximum density ~8000 cells/L
- Moderate cell densities recorded along the Ledyard Bay line (the site of the 2018 bloom), maximum of ~500 cells/L offshore
- Patches of cells present near Utqiagvik (Barrow) (~1000 cells/L)
- A second bloom mechanism is suggested - transport of establishd blooms from the south.

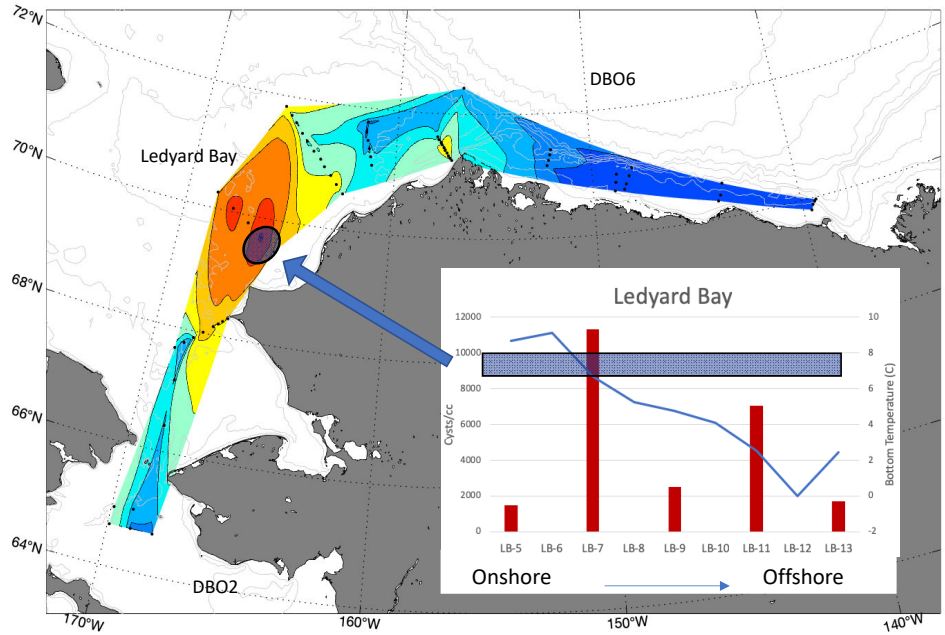


Temperature considerations

High bottom temperatures recorded in 2018 were conducive to germination at highest-density cyst site



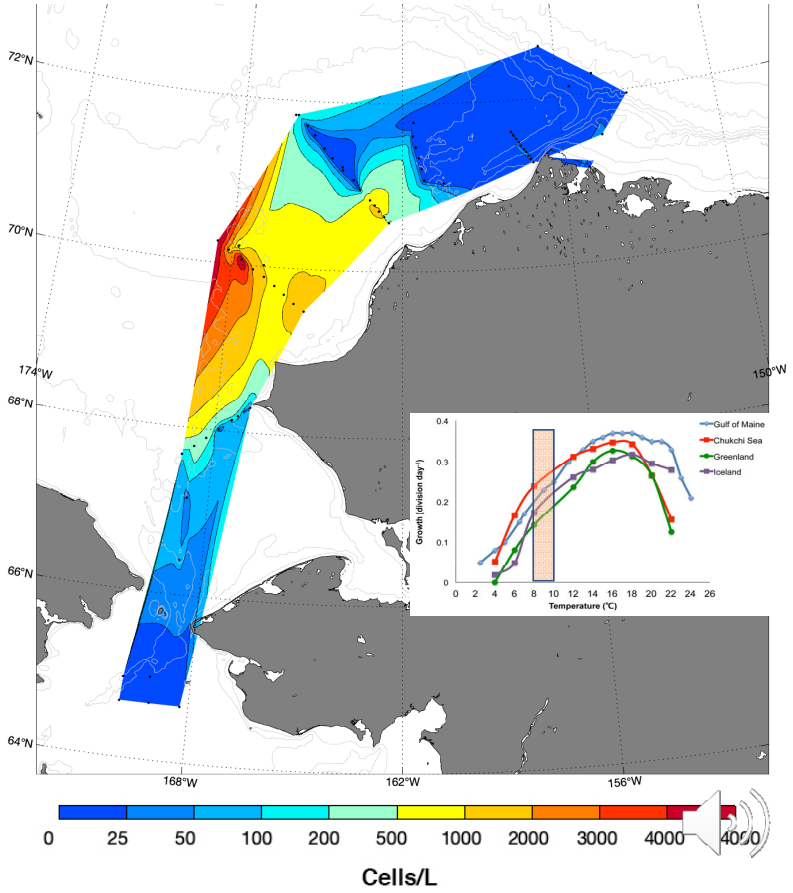
Anderson et al. 2014



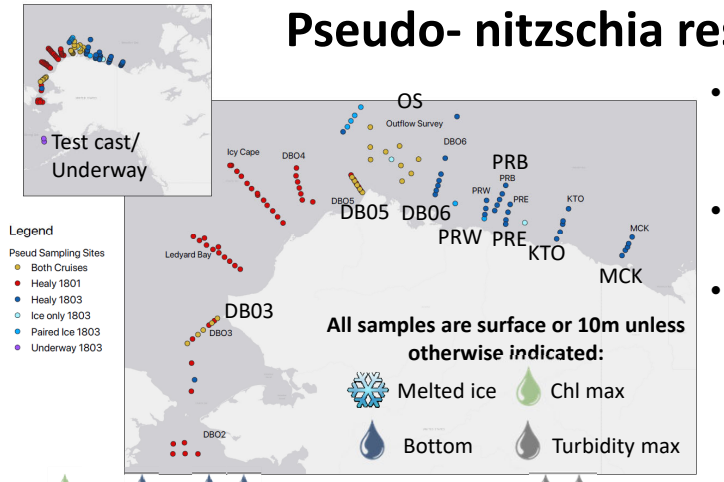
Bottom temperatures recorded during August 2018 indicate strong potential for *in situ* germination; cysts germinate very slowly <2°C; relatively rapid germination possible at 8-9 °C

2018 - Healy 1801 Vegetative Cells

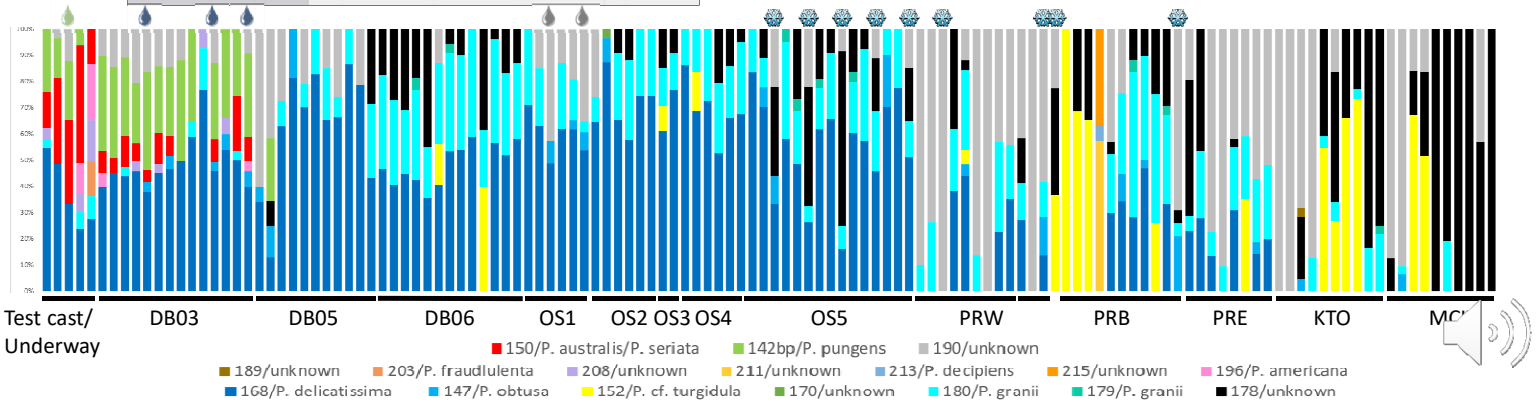
- Sea surface temperatures (8-10°C) in Chukchi were conducive to *Alexandrium* growth and population development



Pseudo- nitzschia results - Healy 1803-November



- Highly toxic *P. australis/P. seriata* **(red)** and other "temperate" species (*e.g., P. pungens* - **green**) detected from Bering Strait to Chukchi Sea
- Several weakly toxic species detected along much of the coast (*P. delicatissima* - **blue**; *P. obtusa* - **aqua**)
- Many species or strains in eastern waters (black, grey) – unknown toxicity



Summary

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- Two extensive *Alexandrium* cyst seedbeds have been documented. Bottom temperatures are high enough to support relatively rapid germination.
- High concentrations of vegetative cells were also detected both years, again with surface water temperatures conducive for algal growth. This suggests that blooms in this region may originate locally and are likely to be recurrent.
- Evidence also suggests that populations transported from the south through the Bering Strait may be a second source of blooms north of the strait.
- We do not know if these blooms are recent phenomena, or have been occurring for many years. Future studies are planned to resolve this.
- Multiple *Pseudo-nitzschia* species were observed throughout the Arctic during these cruises, some of which are highly toxic.
- HABs have significant implications for Arctic food web dynamics, and can affect public health as well as vulnerable marine bird and mammal populations

Acknowledgements

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