Alexandrium cyst distribution and germination in Puget Sound

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Speaker
Cheryl Greengrove, Julie Masura, Stephanie Moore, Brian Bill, Levi Hay, Kiara Eldred, Neil Banas, Eric Salathe, Nat Mantua, James Johnstone, Donald Anderson, Vera Trainer, and John Stein

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Alexandrium catenella cyst distribution and germination in Puget Sound, WA USA

Investigators:
Alexandrium outbreaks, shellfish toxicity, & human illnesses have plagued Puget Sound for decades

Coast Salish People

In North America, Indians of the Pacific Coast apparently were aware of the relationship between red tides and bioluminescence in ocean waters and toxicity in shellfish. They would not eat shellfish when these conditions appeared (Meyer et al. 1928). Illustrative of this, in 1928, Meyer et al. wrote:

“From time immemorial it has been the custom among coast tribes of Indians, particularly the Pomo, to place sentries on watch for Kal ko-o (mussel poison). Luminescence of the waves, which appeared rarely and then only during very hot weather, caused shell fishing to be forbidden for two days; those eating shellfish caught at such times suffered sickness and death. According to a report a band of Indians died about fifty years ago from eating mussels gathered on the Mendocino coast during the month of August.”

The first seemingly documented case of PSP in North America occurred in 1793, when five members of Captain George Vancouver’s crew became ill after eating mussels collected near Fitzhugh Sound in what is now British Columbia (Quayle 1969). One of the five died. Vancouver’s account of this event appears to be the first detailed written description of the symptoms and progression of paralytic shellfish poisoning (Vancouver 1801).

More Recently:
• 1942 – 3 deaths
• 2012 – 9 reported PSP illnesses
• Most years – shellfish bed closures

Harmful Algal Bloom (HAB)

Dinoflagellate

Paralytic Shellfish Toxin (PST) Producer
PS-AHAB

Puget Sound – *Alexandrium* Harmful Algal Blooms

 thou all-destroying but unconquering cell
 from hell’s heart I stab at thee
 for hate’s sake I spit my last breath at thee
 Sink all coffins and all hearses to one common pool!
 and since neither can be mine, let me then tow to pieces,
 while still chasing thee, though tied to thee, thou damned cell!

PS-AHAB

All that most maddens and torments;
all that stirs up the lees of things;
all that cracks the sinews and cakes the brain;
all the subtle demonisms of life and thought;
all evil, to crazy Ahab, were visibly personified,
and made practically assailable in *Alexandrium*.
He piled upon the cell’s thecal plates
the sum of all the general rage and hate
felt by his whole race from Adam down;
and then, as if his chest had been a mortar,
he burst his hot heart’s shell upon it.
Modeling favorable habitat areas for *Alexandrium catenella* in Puget Sound and evaluating the effects of climate change

3-yr Project (2010-2013)  
Funded by NOAA’s Ecology and Oceanography of Harmful Algal Bloom Program (ECOHAB)

Web site:  
www.tiny.cc/psahab
What we knew
(primarily from shellfish)

• Blooms have increased since the 1950s

• Blooms usually occur from July through November

• Interannual variability is high

• Blooms are sensitive to weather and climate – like warm & calm

• Water temperatures > 13°C appear to enhance growth

What we didn’t know...

Where is Alex and what does it like?

How does temperature and salinity affect growth and toxicity?

Factors controlling the germination of cysts?
Interannual variability in cyst abundances?
Relationship between cyst abundance and bloom magnitude?

Need to answer these questions in order to provide early warning of toxic events!
Objectives of PS-AHAB

• How much “seed” is available to initiate blooms and where is it located?
  – Determine interannual variations in *A. catenella* cyst distribution in Puget Sound

• When/where could this seed germinate and grow?
  – Quantify rates of cyst germination and vegetative growth for a range of temperature, salinity, and light conditions
  – Determine the presence/absence of an endogenous clock that regulates cyst germination
  – Model favorable habitat areas for cyst germination and vegetative growth

• How could these factors be altered by future climate change?
  – Evaluate climate change impacts on favorable habitat areas
  – Establish a time series with sufficient depth to provide seasonal forecasts of toxic blooms
The three components of PS-AHAB and who is doing what

- **Laboratory**: Brian/Steph/Vera/Don/Students
- **Field**: Cheryl/Julie/Steph/Students
- **Modeling**: Eric/Nate/Neil

**Steph/John**

**Ocean**
1. Factors controlling benthic and planktonic life stages

• Where are cysts located?
• When can they germinate and grow?
Annual Field Surveys to Map the Abundance of *A. catenella* cysts


Nice Weather!
Sediment Sample Processing

CYSTS (Yamaguchi, Itakura and Ishida, 1995)
- Sonicated
- Sieved
- Preserved (formalin)
- Solubilized cell walls (methanol)
- Stained (primulin)
- Counted (in Sedgewick-Rafter slide using epifluorescence microscopy)

TOC
Loss on ignition

GRAIN SIZE
Beckman-Coulter LS 200
Particle Size Analyzer
Where are cysts located?

*2005 data from Horner et al. (2011): Harmful Algae
Factors controlling cyst germination

PREFERENCES: Light and warmer conditions

Graphs showing germination under light and dark conditions at different temperatures.
Puget Sound *Alexandrium* growth

- Puget Sound *Alexandrium* are euryhaline (20-35 psu) with a broad optimal temperature range (14-24°C)
- Maximal growth rates ~0.3-0.5 μ d⁻¹

Modeled growth response (based on specific growth rates of N & S strains)

Temperature Gradient Bar (Watras et al. 1982)
- Chilling/heating elements
- 12L:12D
- 6 salinities × 19 temps × 2 strains (n=2)

See Brian Bill’s Poster
# Cyst viability (14L:10D, 14°C)

| Site # | Site name                      | Depth (m) | Cysts/cc | % Viability
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Laboratory Experiments to Determine Factors Controlling Growth and Toxicity of Vegetative Cells, and Germination of Cysts.
Questions?