The Effects of Global Climate Change on Harmful Algal Blooms

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Harmful Algal Blooms: An old problem with new focus

- What are Harmful Algal Blooms
  - Cyanobacterium
  - Diatoms
- There has been evidence of harmful algal blooms having toxic effects since the 1800's in written history and they have been found throughout fossil history.

How do they effect veterinary patients

- **Toxins**
  - Cyanobacterium- prokaryotic bacteria that utilizes photosynthesis
    - Toxins
    - **Hepatotoxins:** cylindrospermopsin, microcystins, nodularins
    - **Neurotooxins:** anatoxin-a, anatoxin-a(s), saxitoxins
    - **Dermatotoxins:** aplysiatoxin, lyngbyatoxin-a
  - Red tide- several species of dinoflagellate/phytoplankton
    - **Brevetoxins** (neurological shellfish poisoning)
    - **Domoic acid** (amnesic shellfish poisoning)
    - **Okadaic acid** (diarrhetic shellfish poisoning)
- **Oxygen depletion during respiration and large die offs can**

Cattle Case

Blue-green algae (Microcystis aeruginosa) hepatotoxicosis in dairy cattle

Galey FD, Beasley VR, Carmichael WW, Kleppe G. Hooser SB, Hascheck WM

American J Vet Res. 1987 Sep; 48(9)

- 20 of 60 Heifers showed clinical signs of anorexia, recumbancy and ruminal atony
- 9 of the 20 died
- The 11 that recovered still had elevated liver enzymes 1 week later

Two laboratory case studies on the oral toxicity to calves of the freshwater cyanophyte (blue-green alga)Anabaena flos-aquae NRC-44-1

W W Carmichael, P R Gorham, and D F Biggs
Can Vet J 1977 Mar, 18(3):71-75

1972: Strathmore, Alberta-3 calves died due to A. flos-aquae

1972: Mundare, Albera- 15 head of cattle died due to A. flos-aquae

1975: Bruno Saskatchewan-34 head of cattle died due to Microcyctis sp

Increasing Headlines for Animal Death

https://endtimeheadlines.org/2019/08/toxic-algae-killing-dogs-across-the-country/

Movement and Growth of Blooms

- Cyanobacteria grow naturally in all freshwater environments and can be moved with the current of rivers and streams to new locations accumulating in lakes, ponds and estuaries. Many increase linearly with temperature increase.
- Diatoms and phytoplankton travel on the currents and move with the temperature gradients that are most beneficial to growth.
  - They are photosynthetic and stay in the photic zone
  - They tend to not do well in deep ventral mixing zones
  - They can attach to large boats
- Nutrients which increase blooms include nitrogen and phosphorous from:
  - fertilizers
  - Herbicides
  - Plant die off
  - Air pollution
  - Animal waste

- Increased populations causing increased pollution and denuded coastlines and river beds have lead to increased nutrients in our waterways.

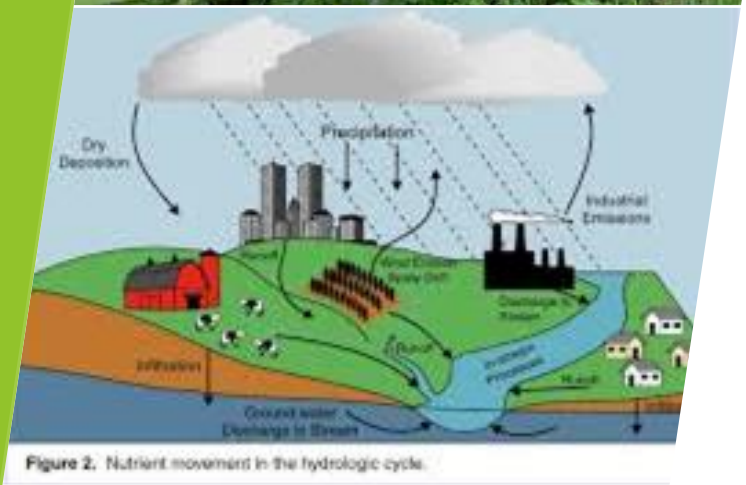
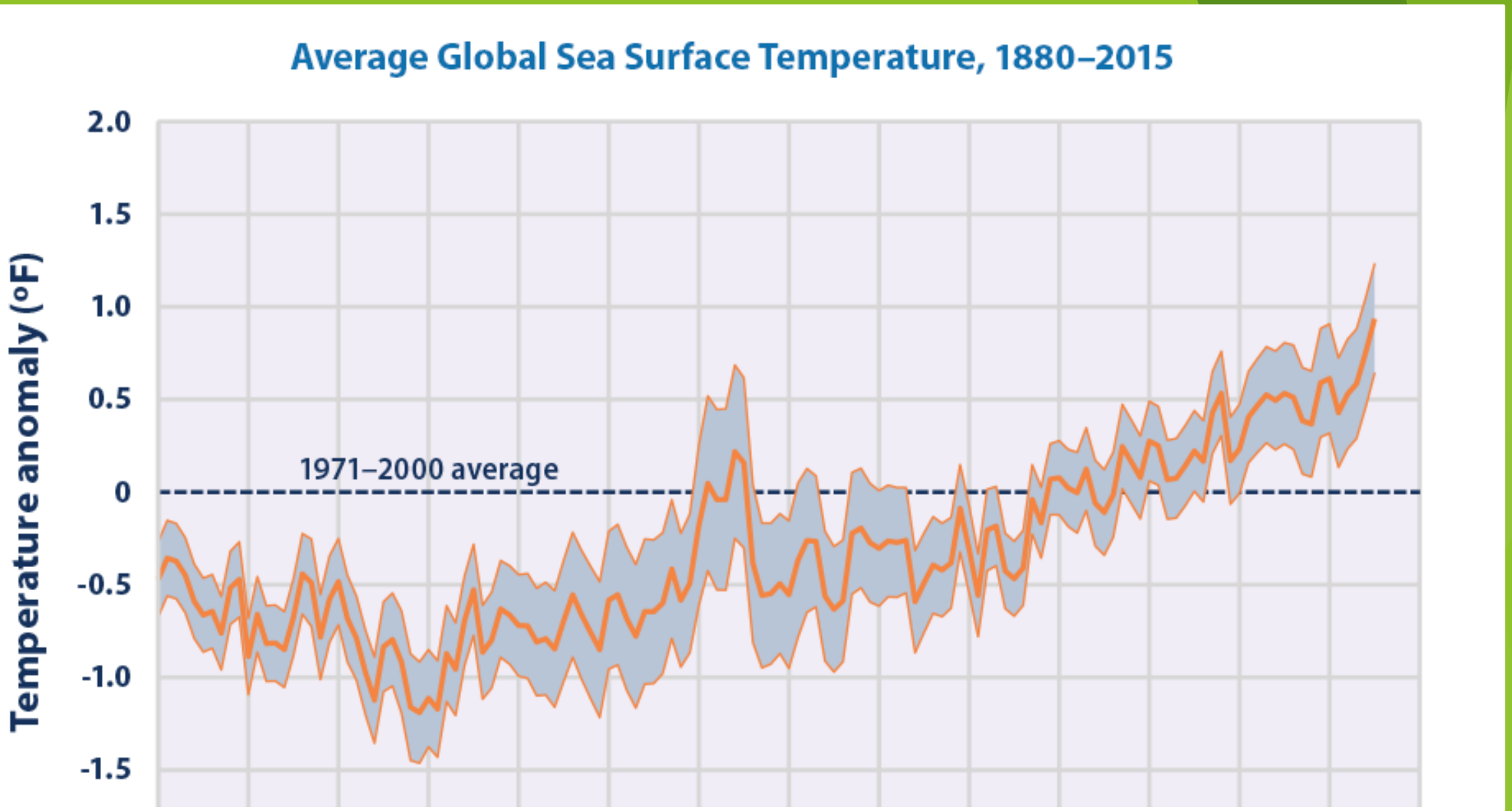


Figure 2. Nutrient movement in the hydrologic cycle.


Average Global Sea Surface Temperature, 1880–2015
Temperature anomaly (°F)
2.0
1.5
1.0
0.5
0
-0.5
-1.0
-1.5
1971–2000 average

The Current Effects of Climate Change on Harmful Algal Blooms

- Alexadrium sp have been found in areas in the Antarctic Sea and in the arctic in Russia and Alaska due to migration and ice melt. This has led to shellfish toxicity in these areas
- A Study in 2009 looking at Microsytisis sp. in the northeast US found that increased water temperatures have lead to an 83% increase in toxic species but only a 33% increase in non-toxic species.

What Should We Expect for the Future

- “Increasing temperature, enhanced surface stratification, alteration of ocean currents, intensification or weakening of local nutrient upwelling, stimulation of photosynthesis by elevated CO2, ocean acidification and increased frequency of heavy precipitation and storm events causing changes in land runoff and micronutrient availability may all produce contradictory species or even strain-specific responses” Halleagraff

Alexadrium sp

- Studies have shown that some species have a very narrow window of temperature that will allow growth, others have shown great increase in growth with higher temperatures
- A. fundyense have had studies that shown that moderate increase temperatures will shorten the dormant period
  - With increased temperature of 3 deg C we will have and increased growth period of 100 days/year at minimum.

Phormidium sp

- Decrease in river flow will increase growth
- Increased water temperature over 14C increased growth

- Expectations: areas with decreased precipitation and increased temperatures will have larger mats of Phormidium.

Colichospermum sp.

- Prefers water with high temperature stratification and has the ability to regulate it's own buoyancy to follow the nutrients and temperature preferred for growth.
- Increased temperature stratification due to climate change will allow this species to have a competitive advantage over other similar species.

Pyodinium bahamense

- This species is found in the Atlantic and the Indo-West Pacific;. It has caused 100 deaths and 2000 human illnesses in the Phyllipines.
- During the Eocene period it was found in fossil records in wider areas and should be expected to reach Sydney, Australia

The Effects of Climate Change on Toxins

- The studies preformed on HABS looking at toxin production and efficacy show a variation between each species and the individual toxins
  - Increases and/or decreases in efficacy related to increased temperature

What is our role

- Increased recognition of toxicity due to harmful algal blooms will allow for further research
- Prevention of harmful algal blooms through nutrient regulation in our waterways will decreases the morbidity
- The use of predictive maps will allow regulators to:
  - Recommend use of shellfish test kits to indigenous people in newly effected environments
  - Recommend water testing to livestock farmers during previously dormant periods
  - Monitor newly established aquatic farms to register their effects on the environment vs. the expected changes from climate change