

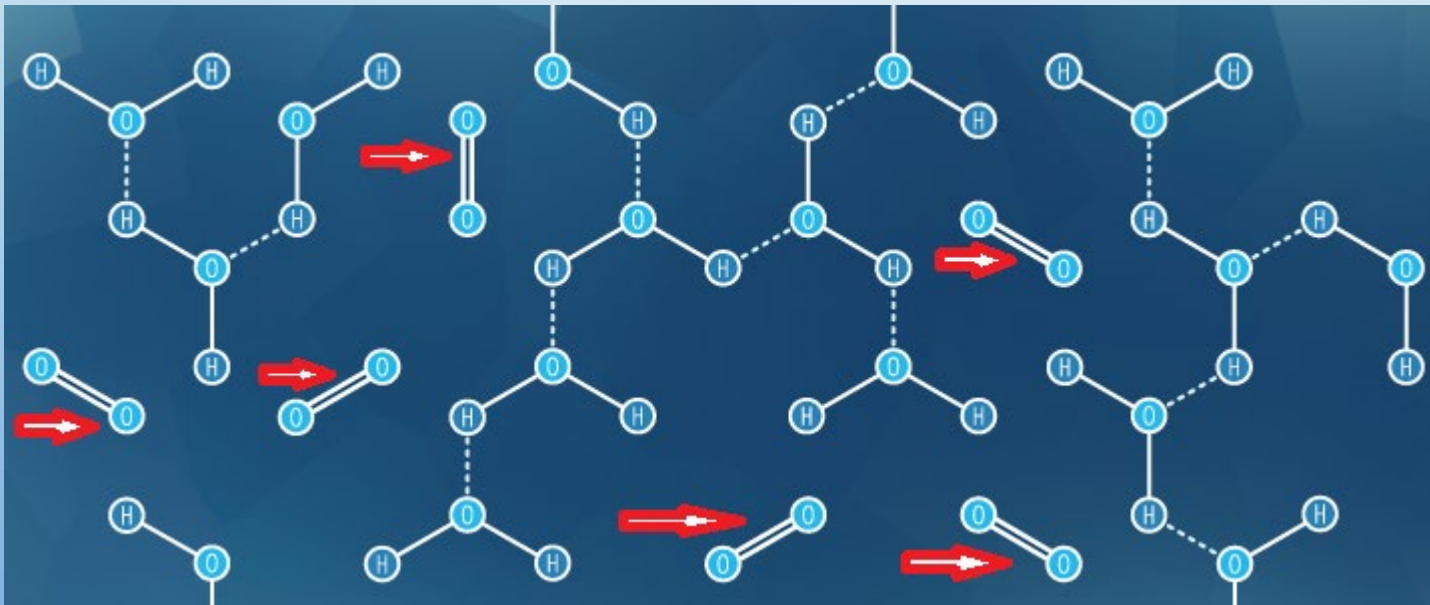
"DO"

- ***What is it?***
- ***What affects it?***
- ***Why does it matter?***

➤ ***What is it?***

Dissolved oxygen (DO) = a measure of the amount of oxygen dissolved in water.

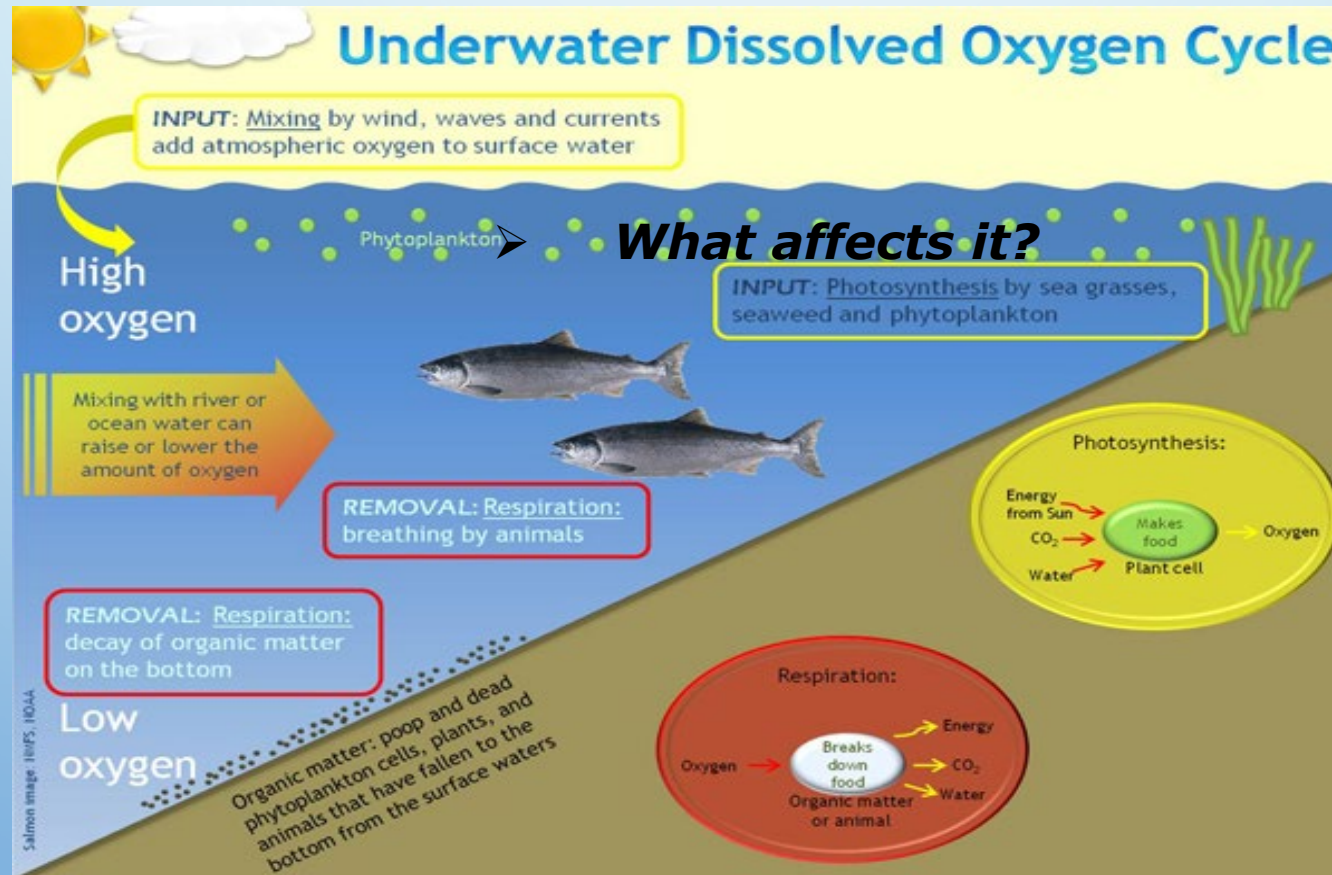
- Dissolved oxygen is the free O_2 molecules within water, and thus available to living aquatic organisms.
- The bonded oxygen molecule in water (H_2O) is in a compound and does not count toward dissolved oxygen levels.
- Imagine free oxygen molecules dissolved in water similar to how salt or sugar molecules dissolve in water when it is stirred.



➤ *What affects it?*

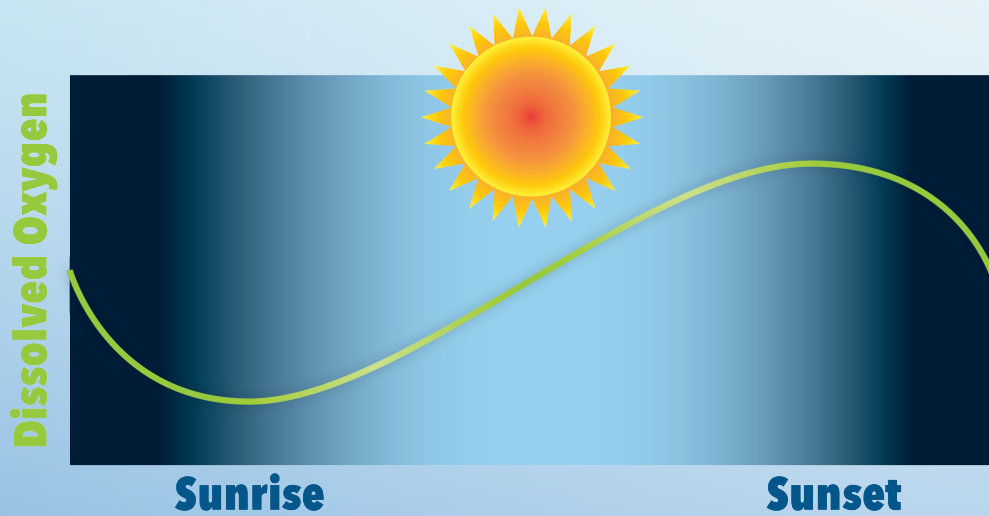
Dissolved oxygen in flux

- Water & air mixing at the surface adds oxygen
- Photosynthesis produces and adds oxygen
- Cellular respiration removes oxygen
- Decomposition process removes oxygen

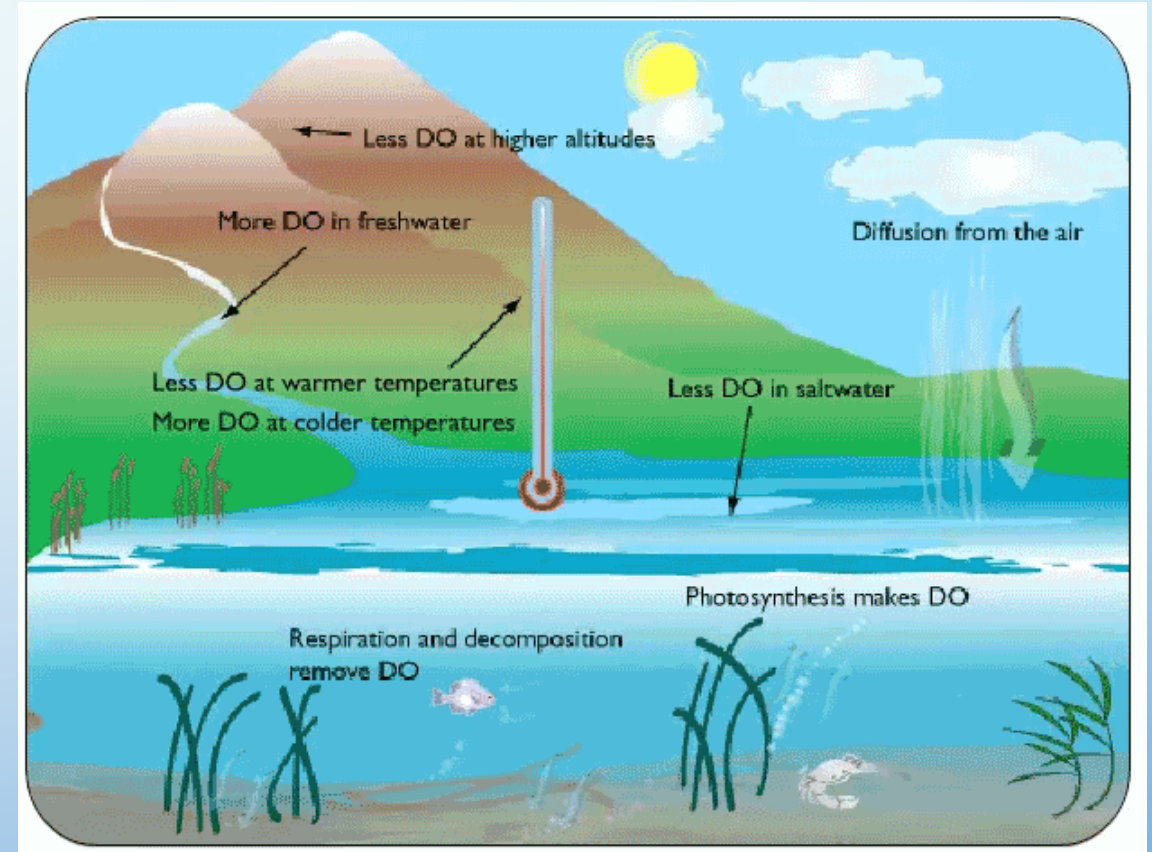


➤ *What affects it?*

- Photosynthesis happens during daytime with sunlight...
- DO levels peak at sunset

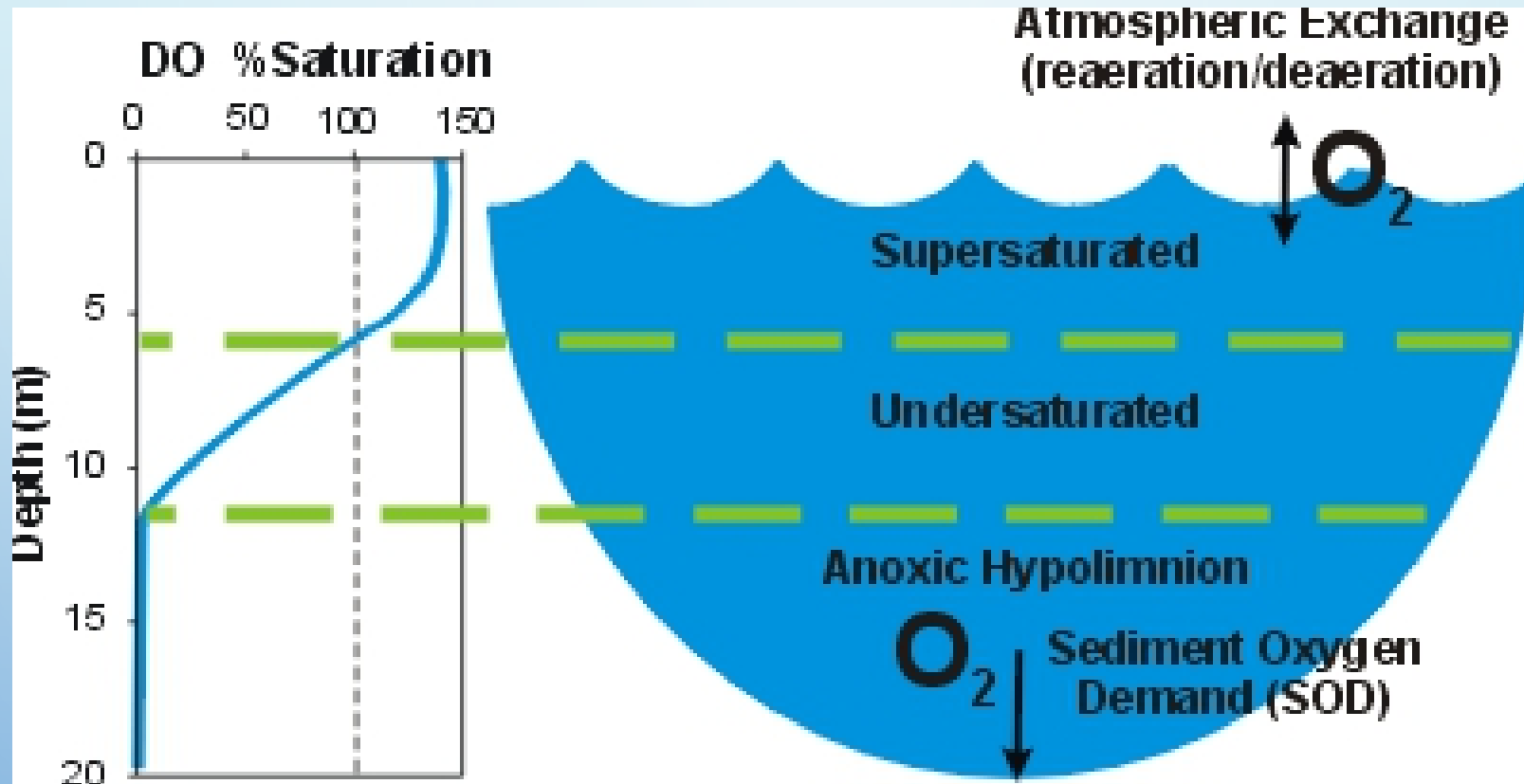


The normal daily cycle of dissolved oxygen production. Production starts when the sun rises and stops when it sets.



➤ **What affects it?**

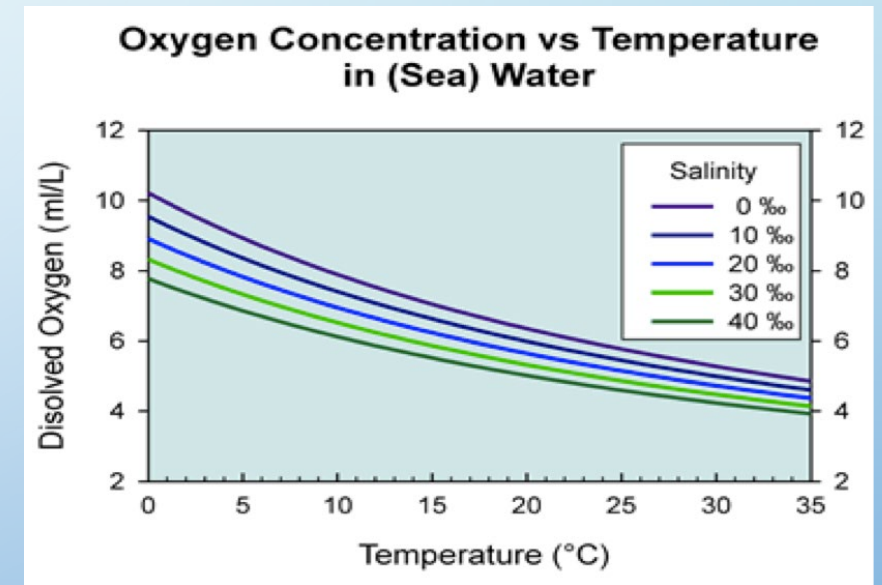
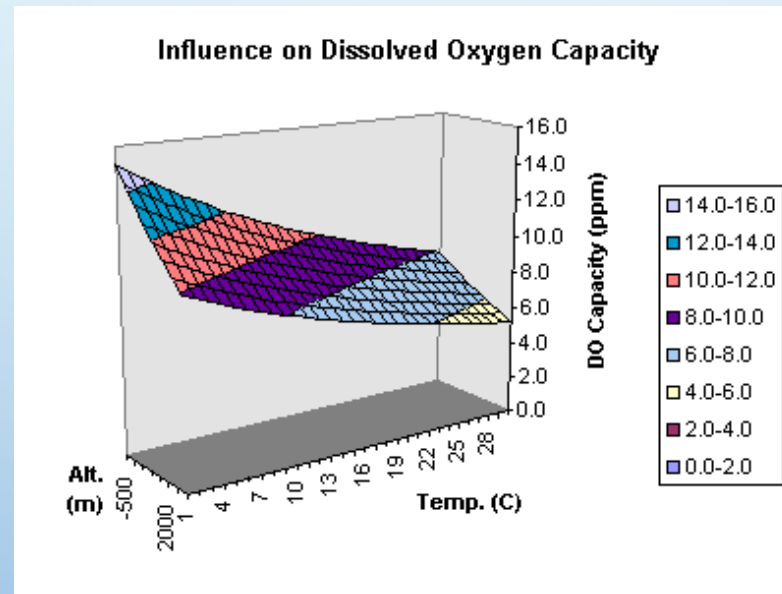
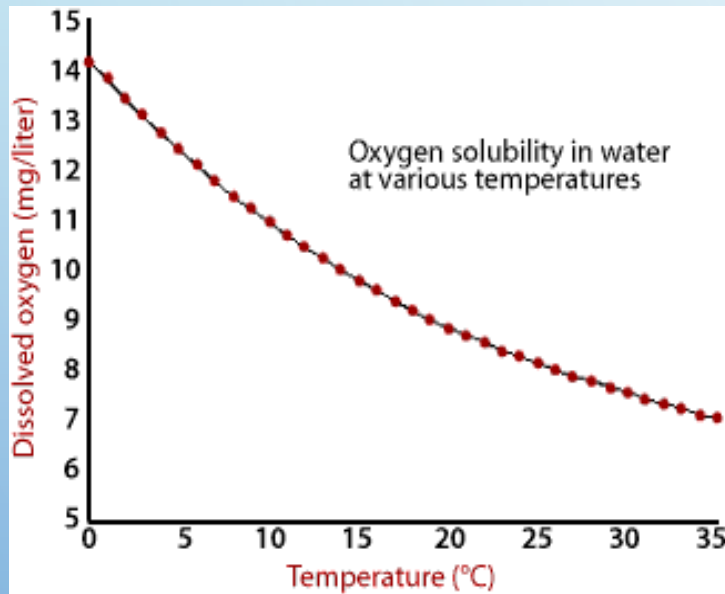
- Oxygen decreases with water depth
- More turbulence at surface means more mixing and more DO



- Dead organisms and animal waste falls to the bottom, more decay takes place at bottom,

➤ ***What affects it?***

- The solubility of oxygen increases at higher barometric pressure (lower altitude)
- The solubility of oxygen decreases with increasing temperature (warmer water)
- The solubility of oxygen in water decreases as the salinity of water increases



➤ ***What affects it?***

What is Nutrient Pollution?

- Nitrogen and Phosphorous are limiting nutrients for growth
- Excess nutrients cause eutrophication and algae blooms



➤ ***What affects it?***

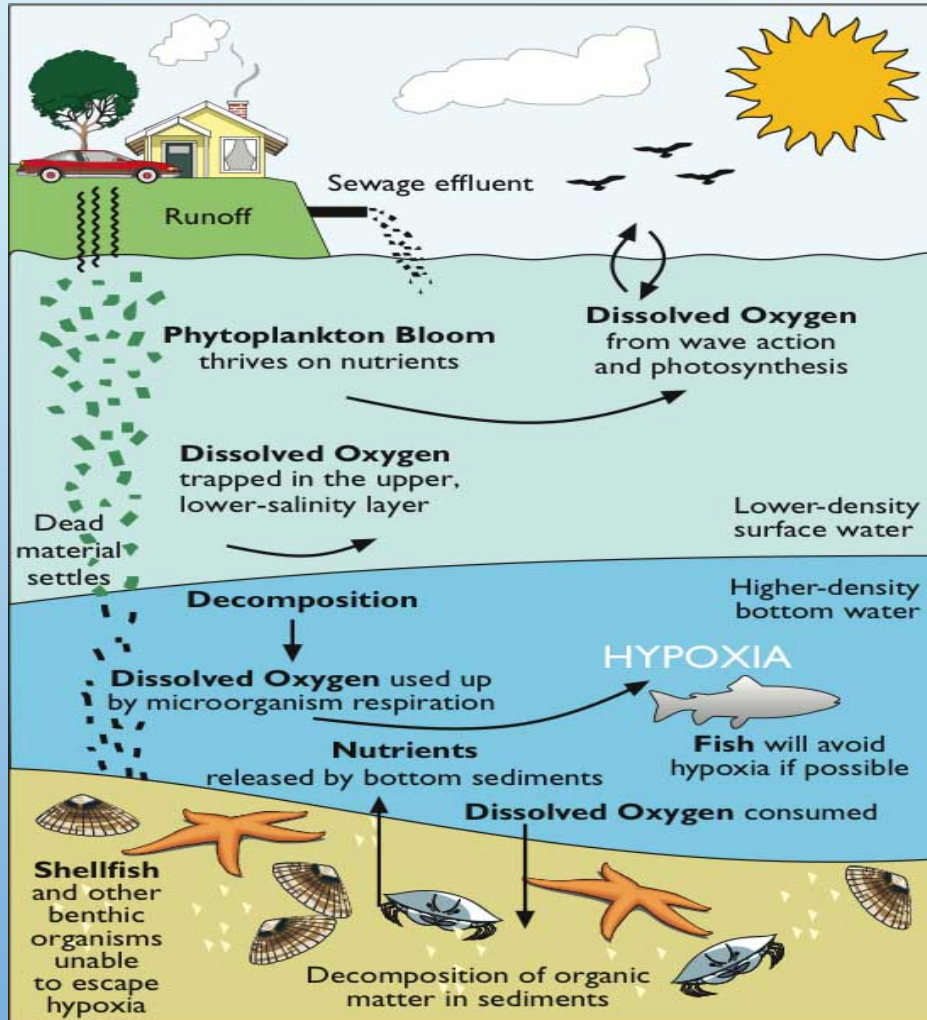
Where Do Excess Nutrients Come From?

- Fertilizers
- Animal Waste
- Untreated Sewage
- Detergents



➤ *What affects it?*

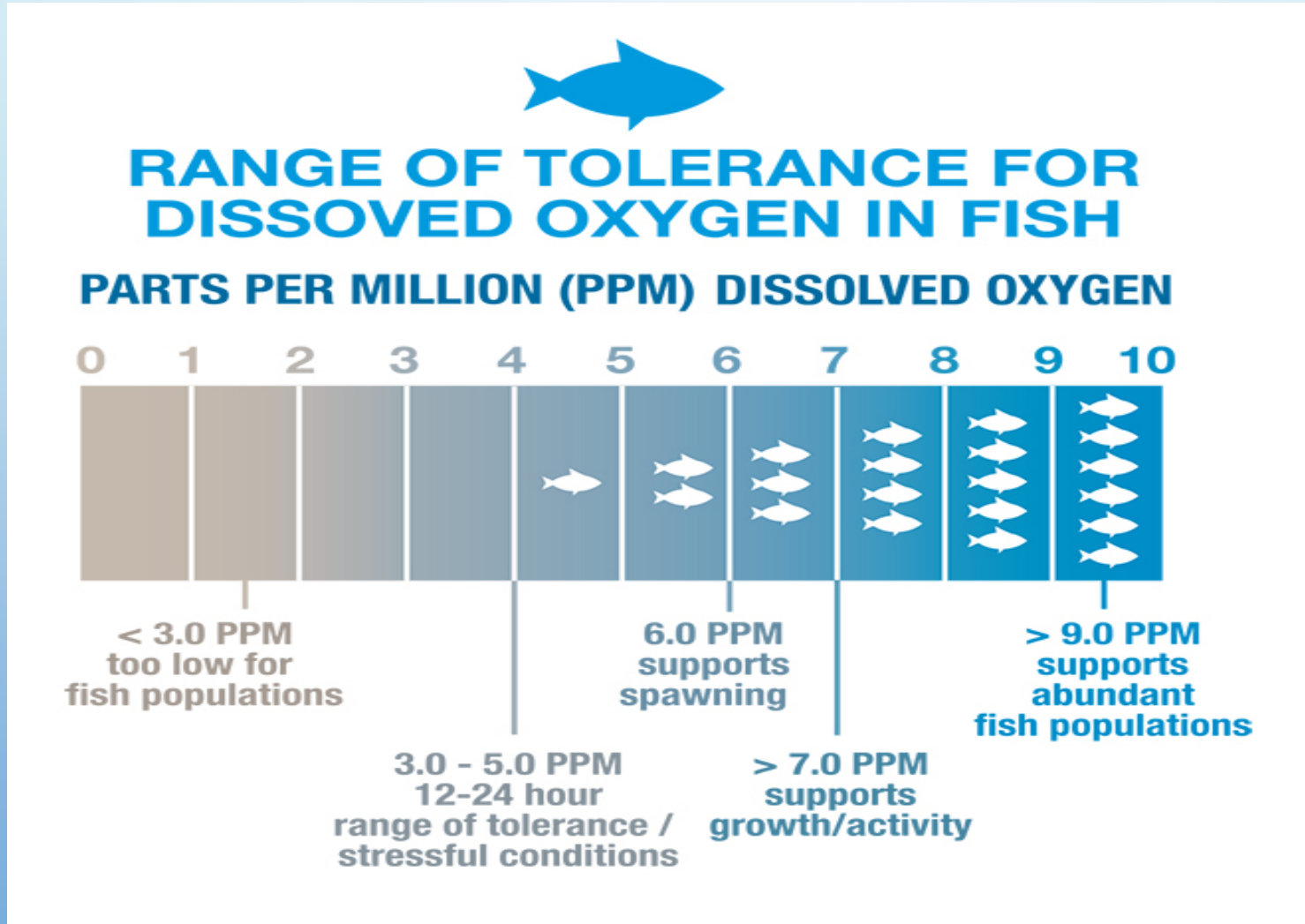
Biochemical oxygen demand (BOD) - the amount of dissolved oxygen consumed by aquatic microorganisms.



- Oxygen is removed from water by respiration and decomposition; chemical processes that consume oxygen.
- Algae blooms block sunlight – decreasing photosynthesis and less O_2 is produced
- As dead organic matter accumulates it leads to a population bloom of microbes that do decomposition
- The microbe bloom increases BOD which decreases DO
- Animal and Human Waste contain coliform bacteria and if water contaminated by high coliform bacteria this also increases the BOD (biochemical oxygen demand) which decreases the dissolved oxygen

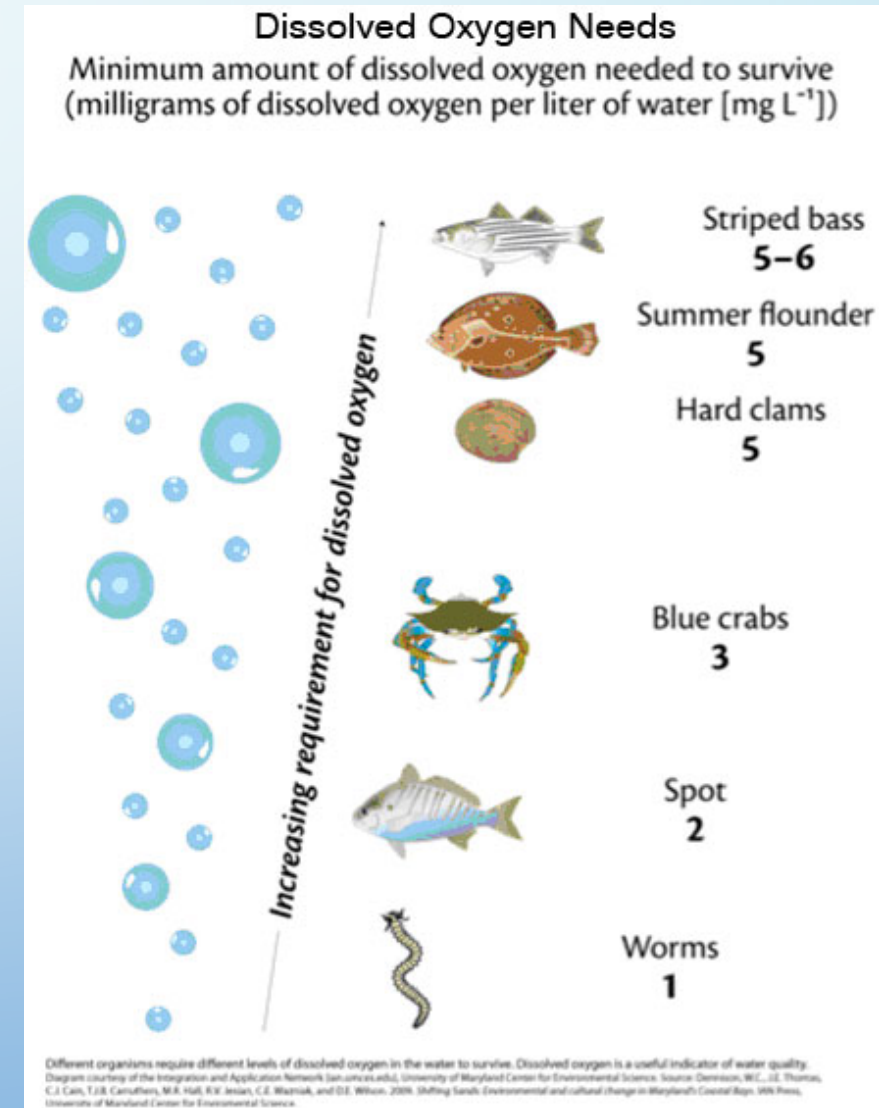
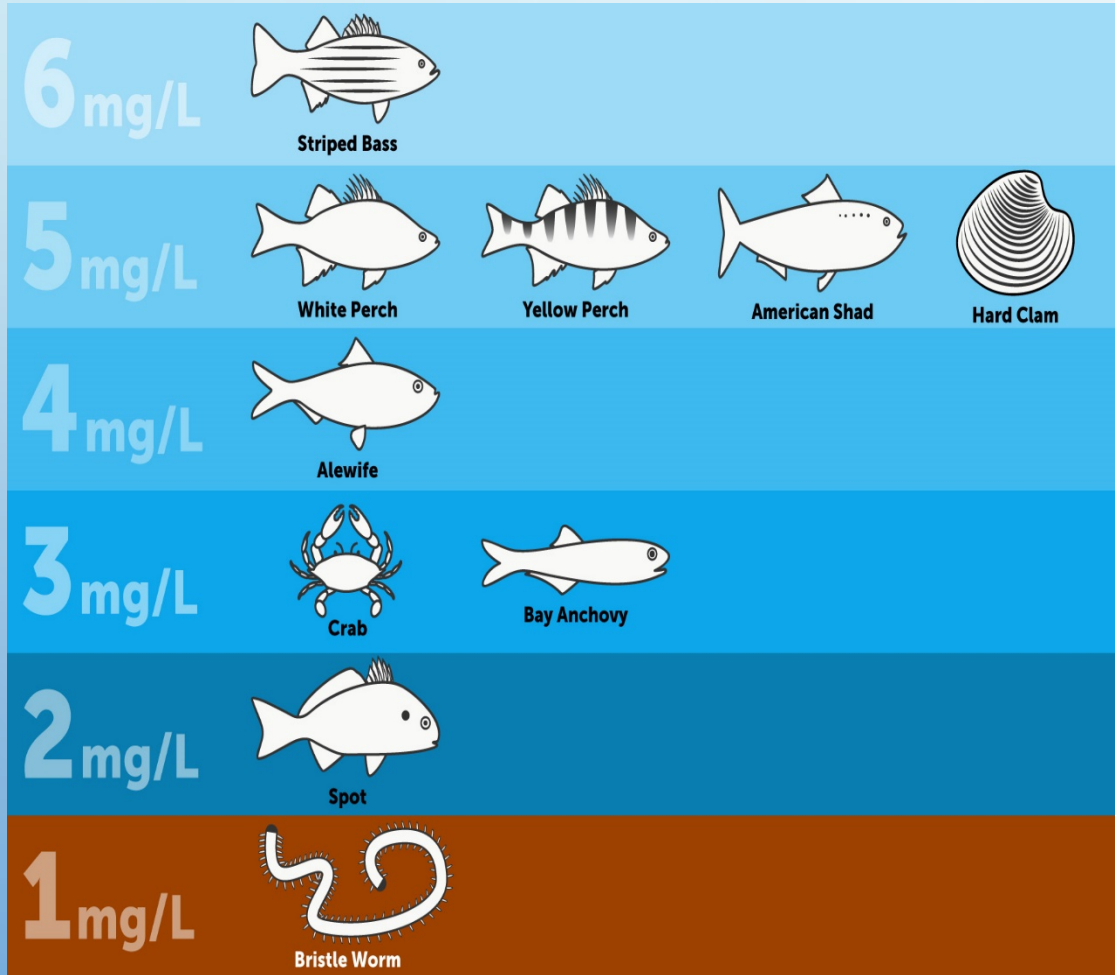
➤ **Why does it matter?**

Aquatic organism activity levels, reproduction rates and growth rates are affected by temperature and available oxygen







➤ Why does it matter?

Different tolerance levels for different taxa



Macroinvertebrates are good bio-indicators of water quality/DO

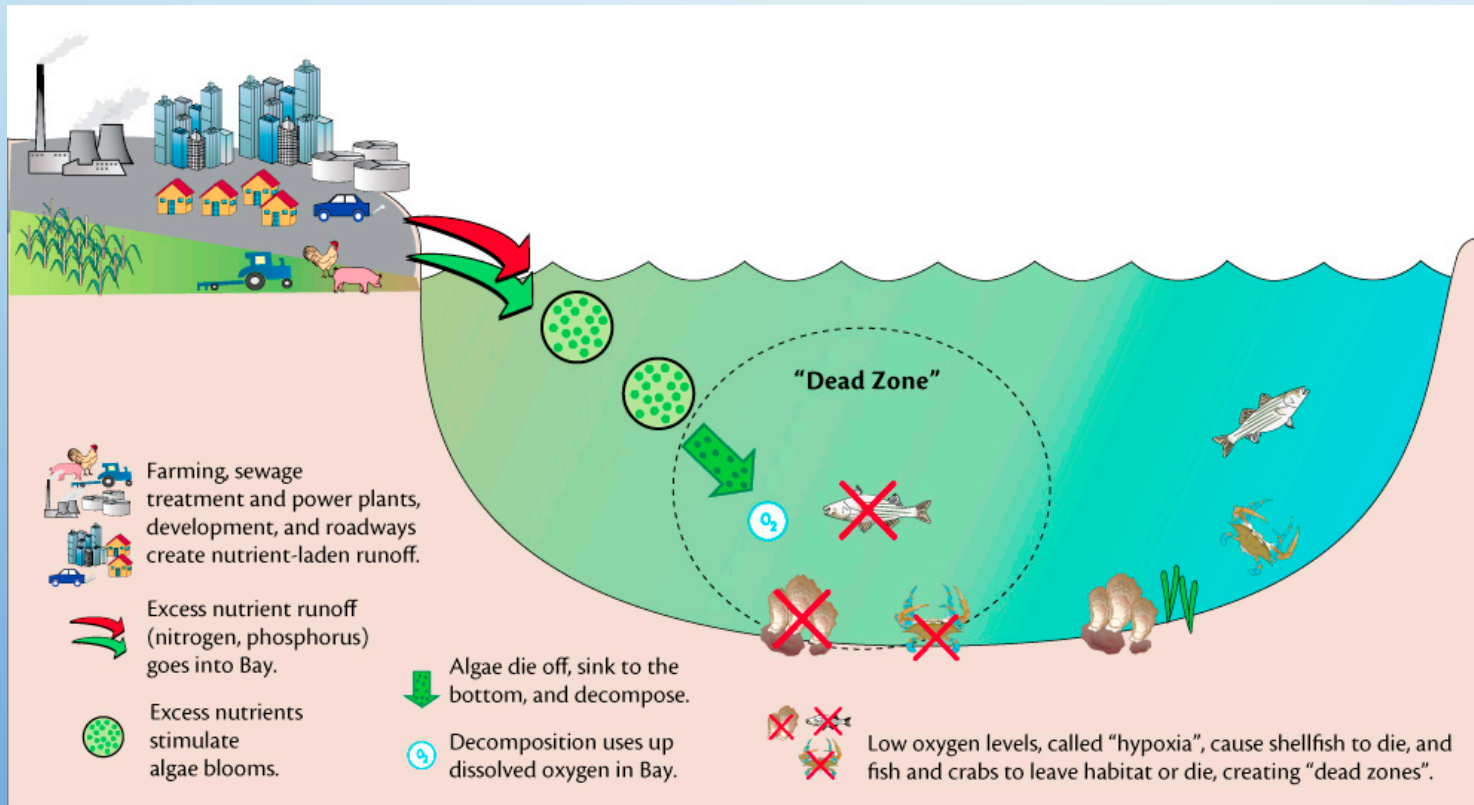
- many are sensitive to sedimentation and chemicals and dissolved oxygen levels
- wide range of pollutant and DO tolerances amongst the taxa.
- have more limited mobility than fish, making them less able to avoid unhealthy water

Green stonefly larva (<i>Chloroperlidae</i>)	Flat-headed mayfly larva (<i>Heptageniidae</i>)	Prong-gill mayfly larva (<i>Leptophlebiidae</i>)	Red midge larva (<i>Chironomidae</i>)
<p>This stonefly breathes directly through its exoskeleton, which requires extremely cool, oxygen-rich water.</p>  <p>Notice the lack of gills.</p>	<p>This "clinger" mayfly clings to rocks and is heavily impacted by chronically high flows and fine sediment.</p>  <p>Small gills require high levels of dissolved oxygen.</p>	<p>This mayfly burrows into the leaf litter and is more resilient against high flows and fine sediment.</p>  <p>Gills are branched and larger.</p>	<p>This "bloodworm" stockpiles oxygen in its body and can thrive in muck.</p>  <p>The red hemoglobin is the same substance which stores oxygen in humans' red blood cells.</p>
← Less tolerant of poor conditions		More tolerant of poor conditions →	

➤ **Why does it matter?**

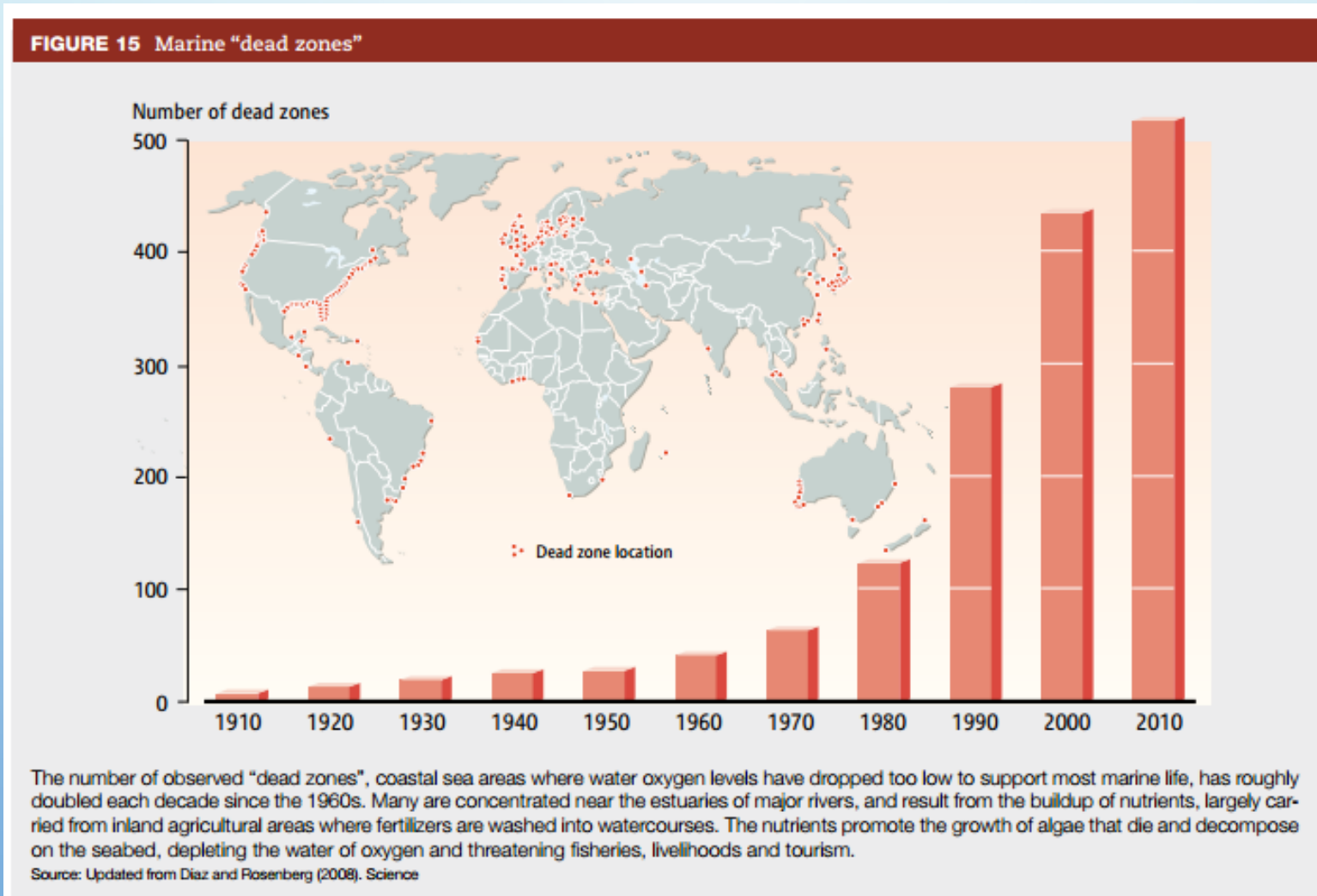
DEAD ZONES – areas with hypoxia (low O₂) or Anoxia (no O₂) that cannot sustain life

- Extensive “dead zones” often form where rivers dump nutrients into estuaries and shallow seas/coastlines.
- Effluents from nearby large cities may be dumped untreated into rivers or the sea.
- Beach pollution, fish kills, and contaminated shellfish result.



➤ *Why does it matter?*

Research has shown that in the past 50 years modern dead zones multiplied, especially along the coasts of the continents, which are most exposed to human activity and wastewater



➤ **Why does it matter?**

Mississippi River Delta Dead Zone

Gulf 'Dead Zone' Chokes Marine Life

The Gulf of Mexico at the Mississippi River Delta experiences a seasonal *hypoxia*, or "dead zone," where there is not enough oxygen in the water to sustain marine life.



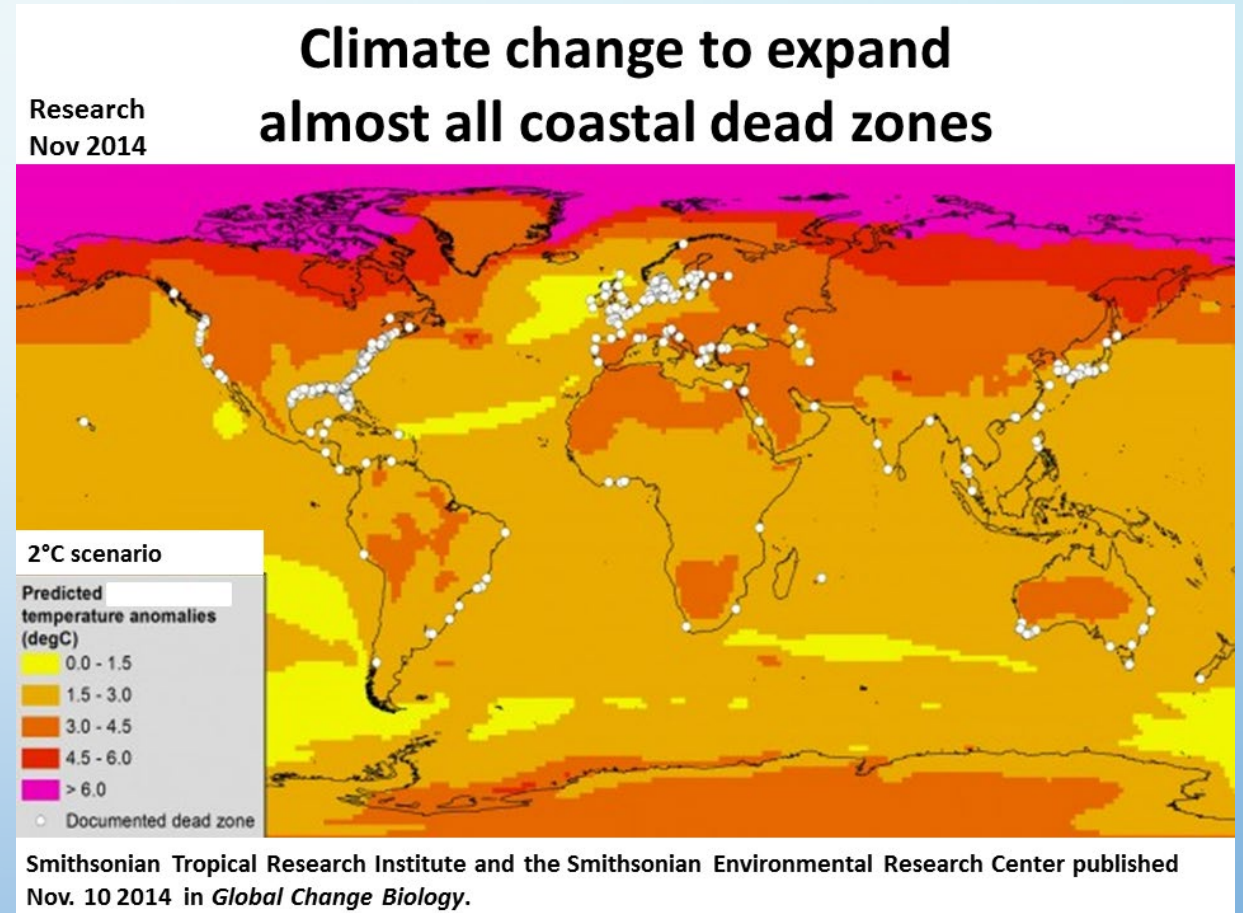
SOURCE: NOAA

InsideClimate News

- Wastewater from cities contains a lot of nitrates and phosphates, acting as a fertilizer in the water.
- Sediments washed by rain from the agricultural fields into the river also provide nutrients that are important for plant growth.
- Similar dead zones in Chesapeake Bay, Lake Erie, Florida coast, the coast of Washington and Oregon - impacting fisheries, recreation, wildlife and human health

➤ **Why does it matter?**

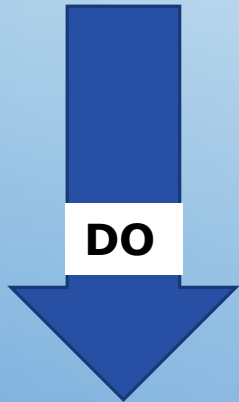
- Geological evidence suggests that such oceanic anoxic events (OAE) happened 95 million years ago during the Cretaceous.
- The exact cause of the past events is debated - likely volcanic eruptions provided nutrients as ash dispersed into Earth's atmosphere, combined with warmer climate of the Cretaceous
- Warm water can hold less dissolved oxygen than cold water.
- Climate change is warming the oceans and therefore they are more vulnerable to oxygen depletion.
- A warmer climate also favors plant growth, making algal blooms more likely.





Increases Dissolved Oxygen in Water:

- **Pressure** - higher barometric pressure (lower altitude)
- **Depth** - shallow water has greater interface with surface and Oxygen in atmosphere
- **Turbulence** - water that is tumbling or bubbling has a high mixing with air at surface
- **Vegetation** - aquatic plants perform photosynthesis and produce oxygen
- **Time of day** - highest at late afternoon/sunset
- **Temperature** - Cooler water
- **Salinity** - less salts in water allows for more oxygen



Decreases Dissolved Oxygen in Water:

- **Pressure** - Lower barometric pressure (higher altitude)
- **Depth** - deep water has no interface with surface and Oxygen in atmosphere
- **Turbulence** - water that is stagnant or still has no mixing with air at surface
- **Vegetation** - lack of aquatic plants means no photosynthesis and no oxygen production
- **Time of day** - lowest at early morning/ sunrise
- **Temperature** - warmer water
- **Salinity** - more salts in water inhibits solubility of oxygen in water
- **Algae blooms** due to excess N and Ph - increased BOD
- **Cellular Respiration/Decomposition** - increased BOD, uses up DO