Note Taker: Julia Winberg
Week Eight: 10/29 to 11/2

Class Oct 29, 2018

Plankton

Greek: Aimless Wanderer

- Give us **50% of the oxygen we breathe**
- Phytoplankton vs. Zooplankton
- Nekton (Active Swimmers)
- Size classes: not expected to memorize but you're expected to know that plankton are not always tiny and that they vary greatly in size.
- Plankton not defined by size but by movement/ ability to move
- We find out what's in the water by concentrating water samples
    - Net
    - Bongo net
- Phytoplankton: Grass of the sea
    - Primary producer, base of the food chain
- In the ocean, primary producers are autotrphs
    - CO_2 + Water + Light → Organic Matter, Oxygen
    - Autotrophs Respire Oxygen
- Food Web: In the ocean, most primary production occurs in surface water
- Chlorophyll: Proxy for primary production (if chlorophyll is present, so is production)
    - Chl. a, has a green color to it
- Low productivity in gyres, high productivity around river runoff
- Phytoplankton account for 47% of Global Primary Production, 50% of breathable oxygen, but are only 0.2% of the earth's biomass
    - They do not live very long and they are super tiny.
- Common Phytoplankton
    - Diatom
    - Dinoflagellate
    - Coccolithophore
    - Cyanobacteria
- Diatoms
    - Made of Silica (SiO_2)
    - "glass houses"
    - Present in fresh water and the ocean
    - Very important, nutritious, especially in coastal areas
    - Fix CO_2
    - When they begin to die, they will glom together to sink their carbon to the bottom of the atmosphere (tiny heroes)
    - They have an exterior test or shell and a silica frustule (photos are in slides)

    - Fresh water Diatoms will have bilateral symmetry, Saltwater diatoms will have radial symmetry
    - Cannot swim, but will move vertically or horizontally, **can** migrate
- Dinoflagellates
    - Cellulose, some photosynthesize, some are both autotrophic and heterotrophic
    - Some live symbiotically with other organisms who can exist with them
- Coccolithophores
    - CaCO3
    - Covered in coccolith plates
    - Can be seen from space, milky color
    - White Cliffs of Dover
- Cyanobacteria
    - Associated with carbon fixation
    - CaCO3
    - Likely the reason oxygen is available on the earth in the first place,fixed harmful chemicals for years through stromatolites
- Prochlorococcus
- Photosynthesis
    - Using solar energy
    - Buried sunlight
    - We're all made of sunlight and CO2
    - Plankton feed the entire ocean while living in just the first 200m of surface water
    - Weigh far less than terrestrial plants, but will photosynthesize more
    - 1000s of species
    - There is even light-emitting phytoplankton

There are some great photos in these set of slides about Phytoplankton distribution, and we watched a great video in class about it as well → check it out if you can!

Class Oct 31 2018

- Harmful Algal Blooms
    - Red Tide: Karenia
    - Brown Tide: Aureoumbra
    - Cyanobacterial Blooms, Baltic Sea

- Red Seaweed is NOT red tide. Red algae is single-celled.
- When they are abundant, they block sunlight in the ocean, deplete oxygen (excessive respiration, decomposition), and cause mechanical irritation (damaging fish gills). Think of the shape of some of these algae: if you're a fish, it can feel like swallowing razors
- Dead Zone: Gulf of Mexico
- **Hypoxia:** Low oxygen conditions
- **Apoxia:** Zero Oxygen Conditions

- Benthic organisms seriously harmed during algal blooms (stuck to the bottom)
- Fish trapped in low oxygen, larvae unable to survive,
- Red Tide
    - Toxic
    - Causes Fish Kills
    - Naturally Occuring
    - Karenia Brevis
        - Produces a toxin that damages the central nervous system of the fish
- Dinoflagellates cause a lot of blooms
    - Single-celled
    - 2 flagellae
    - Bioluminescent
    - 6-8m per Liter is considered a Bloom
- Red Tides cause Humans to get sick
    - Cold and flu-like symptoms, serious illness
    - Can also be caused by consuming infected shellfish
- We impact red tides and algal blooms: The more fertilizer we put in water, the more algal blooms
- Cyanobacterial Toxins
- Neurotoxic Shellfish Poisoning
- Amnesic Shellfish Poisoning
- 1961: Seabirds invade Monterey Bay, Domoic Acid Toxicity
- Pseudo-Nitzschia
    - Caused by silica
    - Varying toxicity
- Domoic Acid Poisoning
    - Passes through the blood-brain barrier
    - Binds to receptors and causes confusion, craze
    - Shrunken hippocampus in sea lion brain with domoic acid poisoning
    - Brain function fundamentally disrupted
- Connected!
    - Algal Bloom → Bait, Filter Feeders→ Bird→ Megafauna
    - As larger fauna eat toxins, they accumulate them in larger numbers, higher levels like in tuna and swordfish
    - Pseudo-nitzschia likely a factor in crazed Birds
- Map of Algal Blooms
    - Abundance in warmer areas
    - Regional
    - Present in freshwater
- Post 1972, algal blooms are more present, more harmful to the environment
    - New species fo algal bloom
    - Also increased: our ability to detect algal blooms
    - Increases over time are **always** impacted by our ability to detect said increases

- Primary Productivity
    - Polar Oceans: Nutrients abundant due to mixing
    - Limited by sunlight, darkness in winter
    - Partly covered by Sea Ice
    - Diatoms Dominant
    - Peak bloom in spring due to light
    - Eaten/ fed upon by zooplankton biomass
- Tropical Ocean
    - Permanent Thermocline, pycnocline
    - Stable water column, constant sunlight
    - Productivity does not change seasonally
- Factors:
    - Polar: Sunlight
    - Tropical: Nutrients
- Exceptions
    - Equatorial Upwelling in the Eastern Pacific
    - Coastal Upwelling
    - Coral Reefs
- Temperate
    - Strong Seasonality in productivity
    - Limited by light
    - Progressively become nutrient limited throughout the seasons
    - Fig a. In these slides is very important!!

Class Nov 2, 2018

- Photosynthesis and Furious Feasting
- Primary Productivity
    - Organic Matter synthesized from inorganic substances
    - Photosynthesis: producing organic matter from CO_2 and H_2O using light energy
- $CO_2 + H_2O + Light \rightarrow$ Organic matter and Oxygen
- $6CO_2 + 6H_2O + Light \rightarrow C_6H_{12}O_6 + 6O_2$
- Photosynthesis consumes CO_2 and respires O_2
- Biomass
    - Static measure, in grams, of how much volume of a species there are
- Primary Productivity (PP)
    - Dynamic measure of how much matter is made and produced per unit time
    - Described in a rate, per day
- Controlling PP and Phytoplankton presence...
    - Photosynthetic Light
    - Dissolved inorganic nutrients
    - Grazing by zooplankton (think: copepods, larvae)

- Most Common Limiting Factors:
    - Nutrients
    - Light
- Light
    - Review: Zones! Photic/Euphotic, Dysphotic, Aphotic
    - Not all light is the same.
    - Light is defined on a spectrum, and there is a part of the spectrum optimal for Photosynthesis, called PAR spectrum
    - Sweet spot: 400-700nm allows PS
- The euphotic zone is NOT static and phytoplankton cannot actively travel, thus are exposed to a bunch of different light
- Only 1% of light energy from the sun continues 100m into the ocean, this level is aptly named the “1% light level”
- Major Nutrients
    - Phosphorous
    - Nitrogen
    - Carbon
    - Silica
- Nitrate (NO_3^-), Nitrite (NO_2^-), and Ammonium (NH_4^+) make up **DIN, or Dissolved Inorganic Nitrogen**
- Phosphate (PO_4^{3-}) makes up **DIP- or Dissolved Inorganic Phosphorus**
- Silicate (SiO_4)
- In general, in the ocean, Nitrogen is the limiting nutrient
- $(106CO_2)+(16NO_3^-) + (PO_4^{3-}) + (122H_2O) + (19H^+) + \text{Light} \rightarrow (CH_2O)_{106}, (NH_3)_{16}, (H_3PO_4) + 138O_2$

    All these numbers are the recipe for generic organic matter
- Redfield Ratio: C:N:P → 106:16:1 in phytoplankton, no matter where you go in the ocean
- This IS affected by climate change and a warming ocean
- In Diatoms, the ratio is C:N:P:Si→ 106:16:1:16
- Justus von Liebig
    - Liebig’s law of the minimum
    - There is always 1 nutrient that limits the growth of *x*
    - Barrel Example: If you were to fill a barrel with varying slats with water, you could only fill it to the height of the lowest slat before water would begin to be wasted
    - There is always a weakest link, a limiting nutrient, and you need to increase the limiting nutrient in order to grow more
    - In saltwater and on land, the limiting nutrient is Nitrogen
    - In freshwater, the limiting nutrient is phosphorous
- Sources of nutrients
    - Runoff
    - Pollution: farms, sewage, manure, emissions
    - Weathering of soils and rocks

    - Cows, methane

****side note**: if anyone is interested in how runoff and sewage can directly affect marine communities, Professor James Porter at University of Georgia has an amazing project about bacteria from human waste (in the ocean due to poor sewage treatment) decimating the Elkhorn coral population of the Florida Keys and how they remedied it. Harvard filmed his lecture about this recently!**

- Sewage Treatment Plants
- Light + CO_2 + Nutrients → Phytoplankton
- What are the products of respiration?
    - CO_2, Nutrients, Humans
- Respiration
    - Organic matter and oxygen → Co_2, Nitrate, Phosphate, and water
    - Consumes Oxygen
    - Produces CO_2
    - Regenerates nutrients
    - This is why sewage treatment matters
- Marine Snow
    - Literally looks like snow falling
    - Deep, dark ocean, pellets of organic matter, fecal pellets and planktonic tests sink
    - Collected in sediment trap
    - CO_2 trapped inside
- More oxygen at bottom of the ocean due to less life down there needing the oxygen and Thermohaline circulation