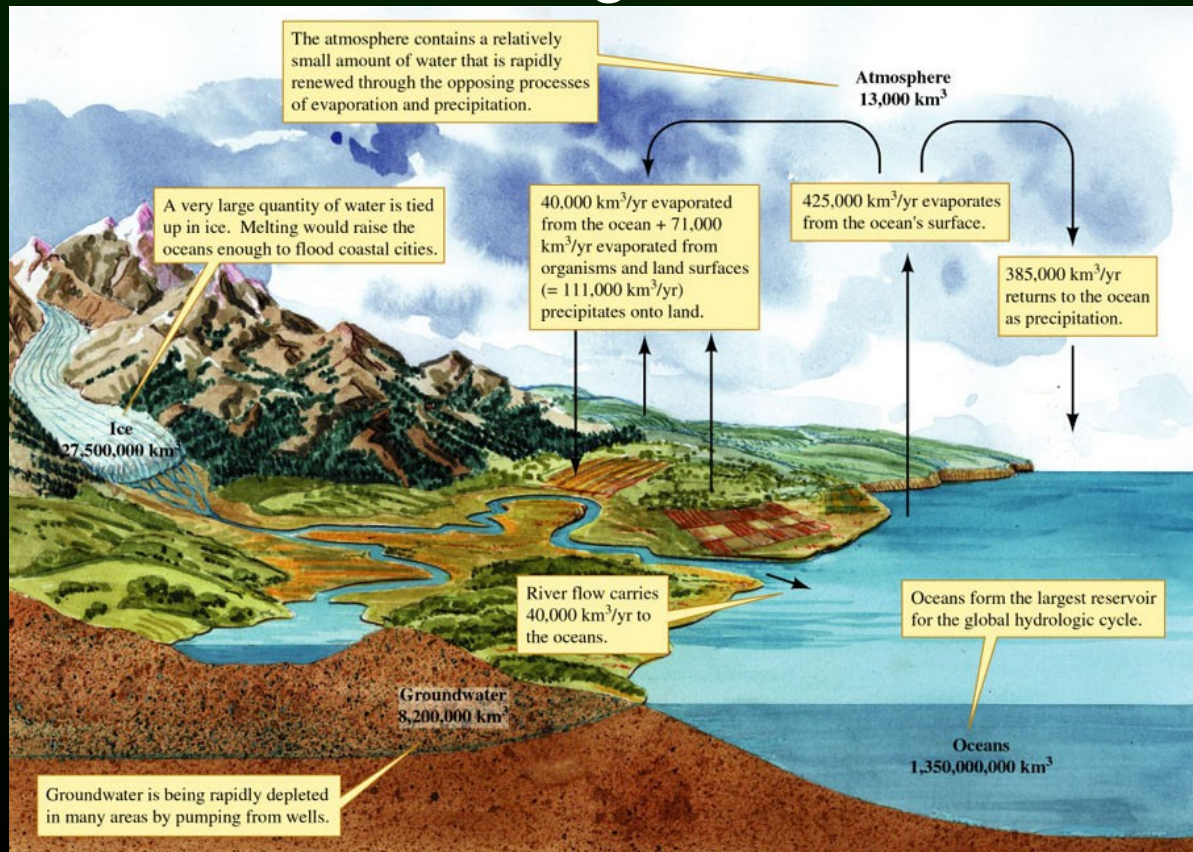
Life in Water – The Organism's Environment

Chapter 3

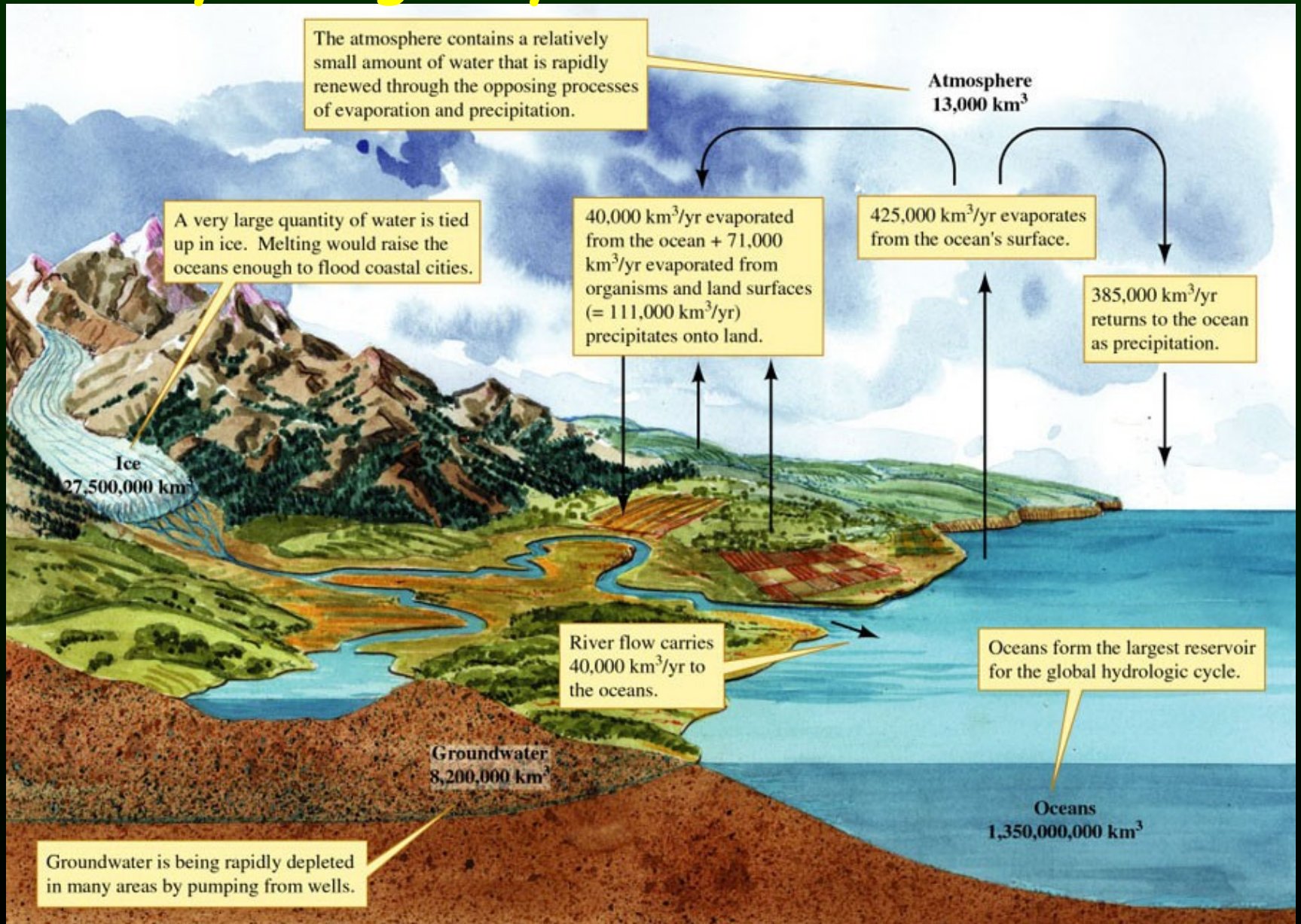
The Hydrologic Cycle

- The hydrologic cycle describes how water is exchanged
- Over 71% of the earth's surface is covered by water:
  - Oceans = 97%. Polar ice caps and glaciers = 2%. Freshwater in lakes, streams, and ground water = < than 1%.

The distribution is not constant!
Why not?



What effect would global warming have on the hydrologic cycle?



The Oceans – largest biome on earth!!!

- Factors for life in the ocean
  - Light
  - Temperature – much more stable than on land!
  - Currents
  - Salinity
  - Oxygen
  - Pressure

Tropics stable, but proc
Tem
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vari
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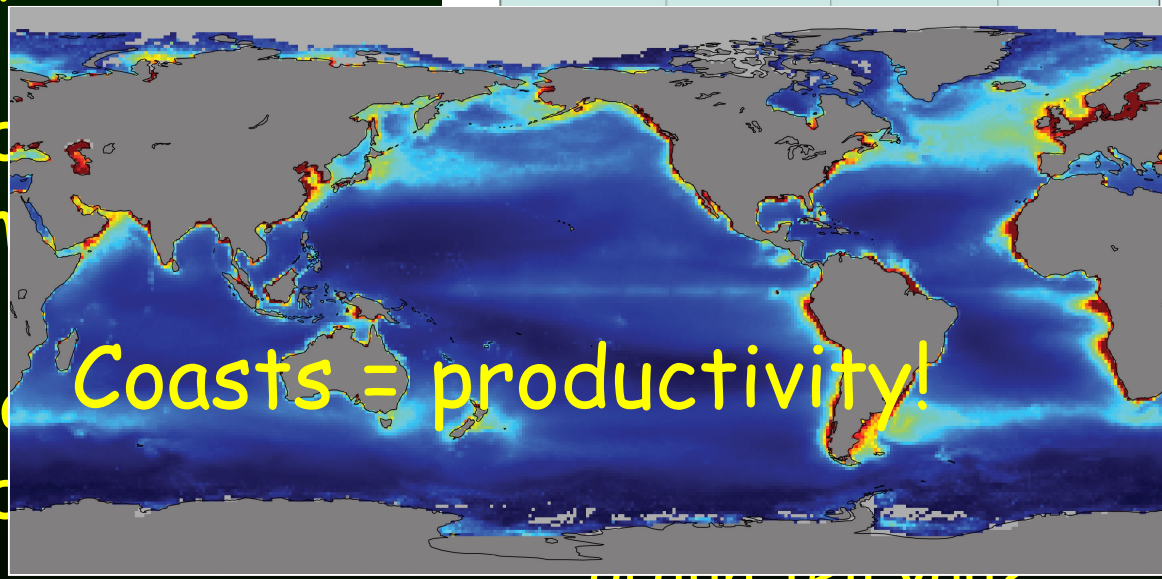
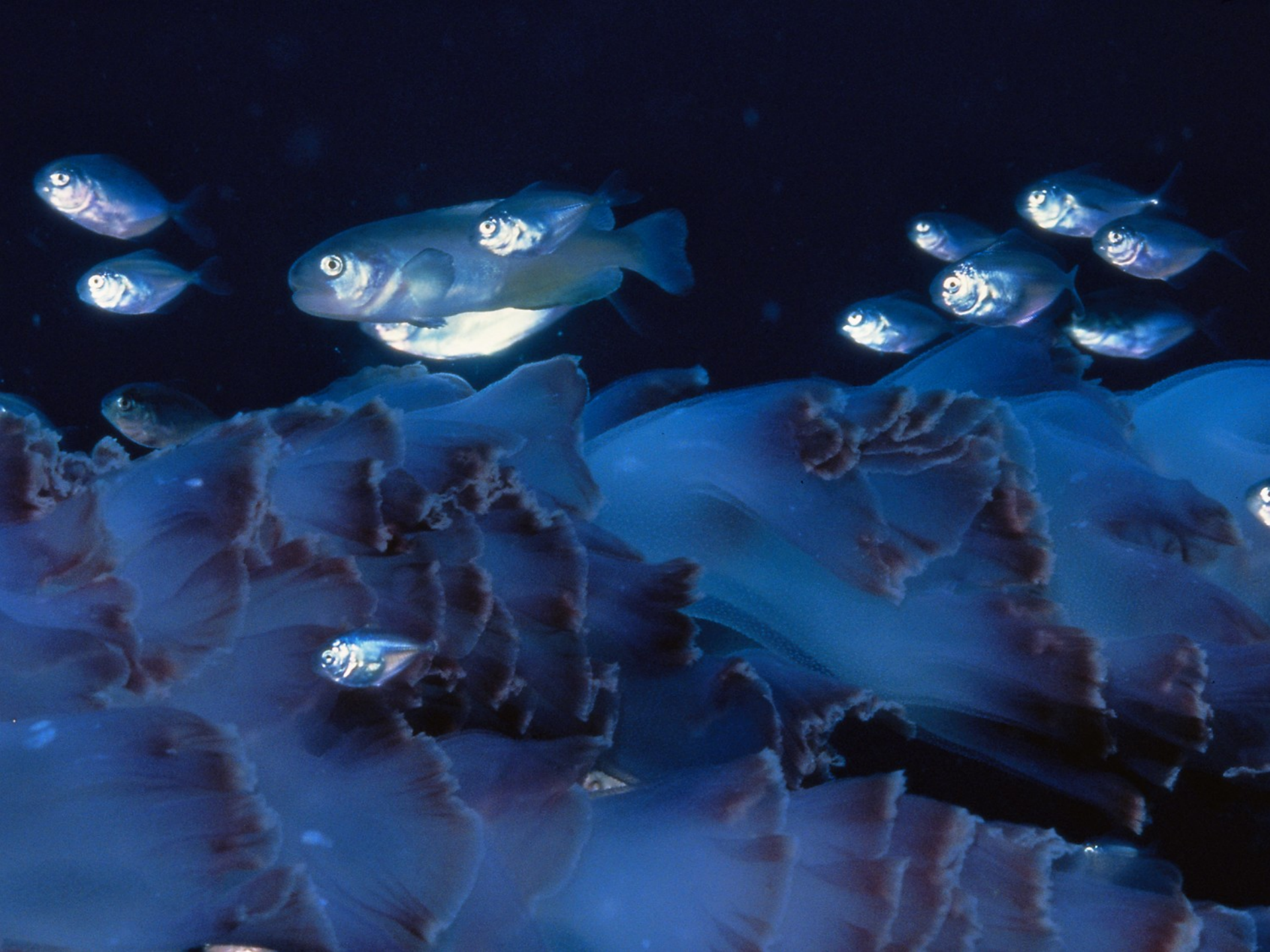
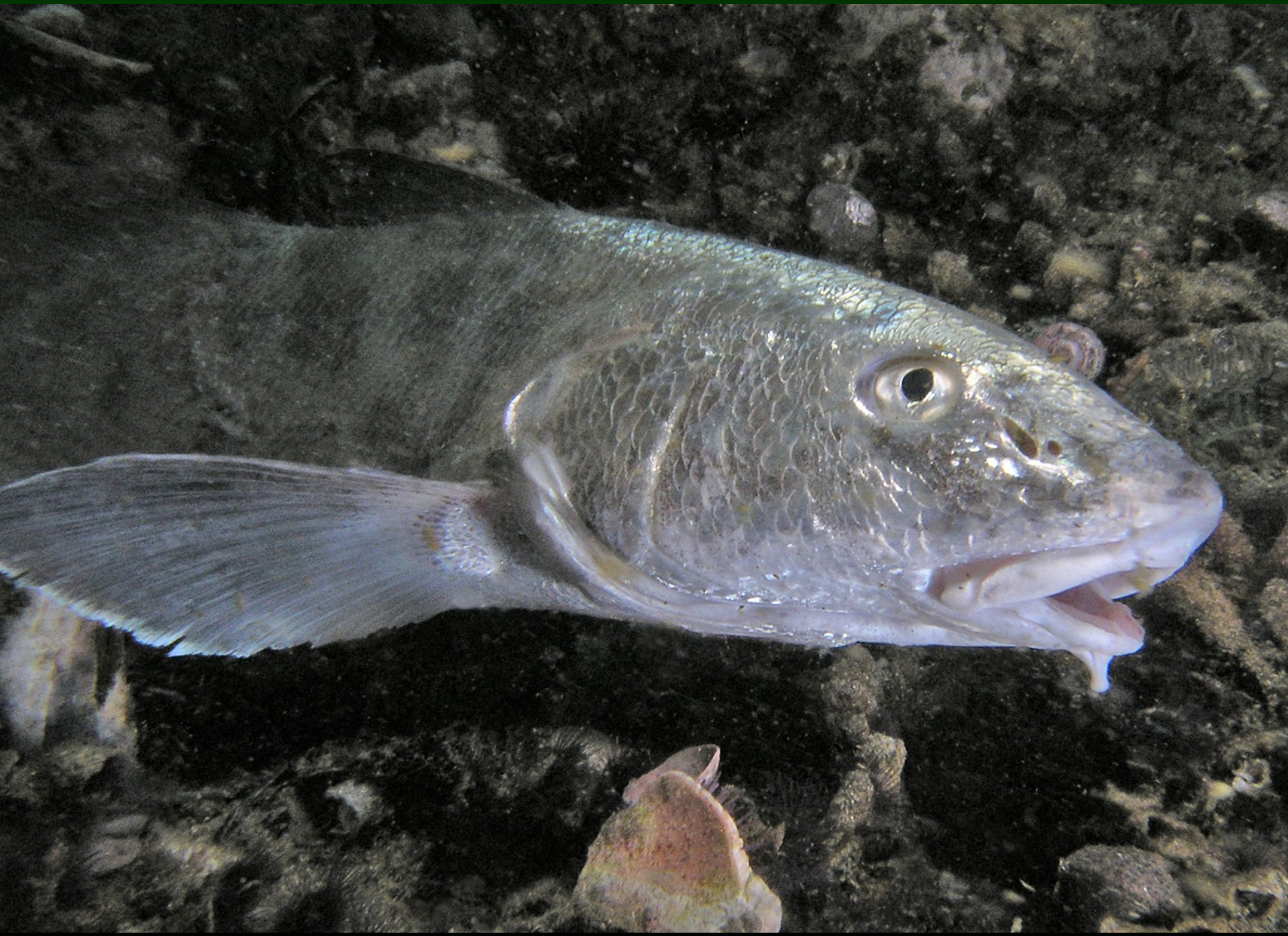
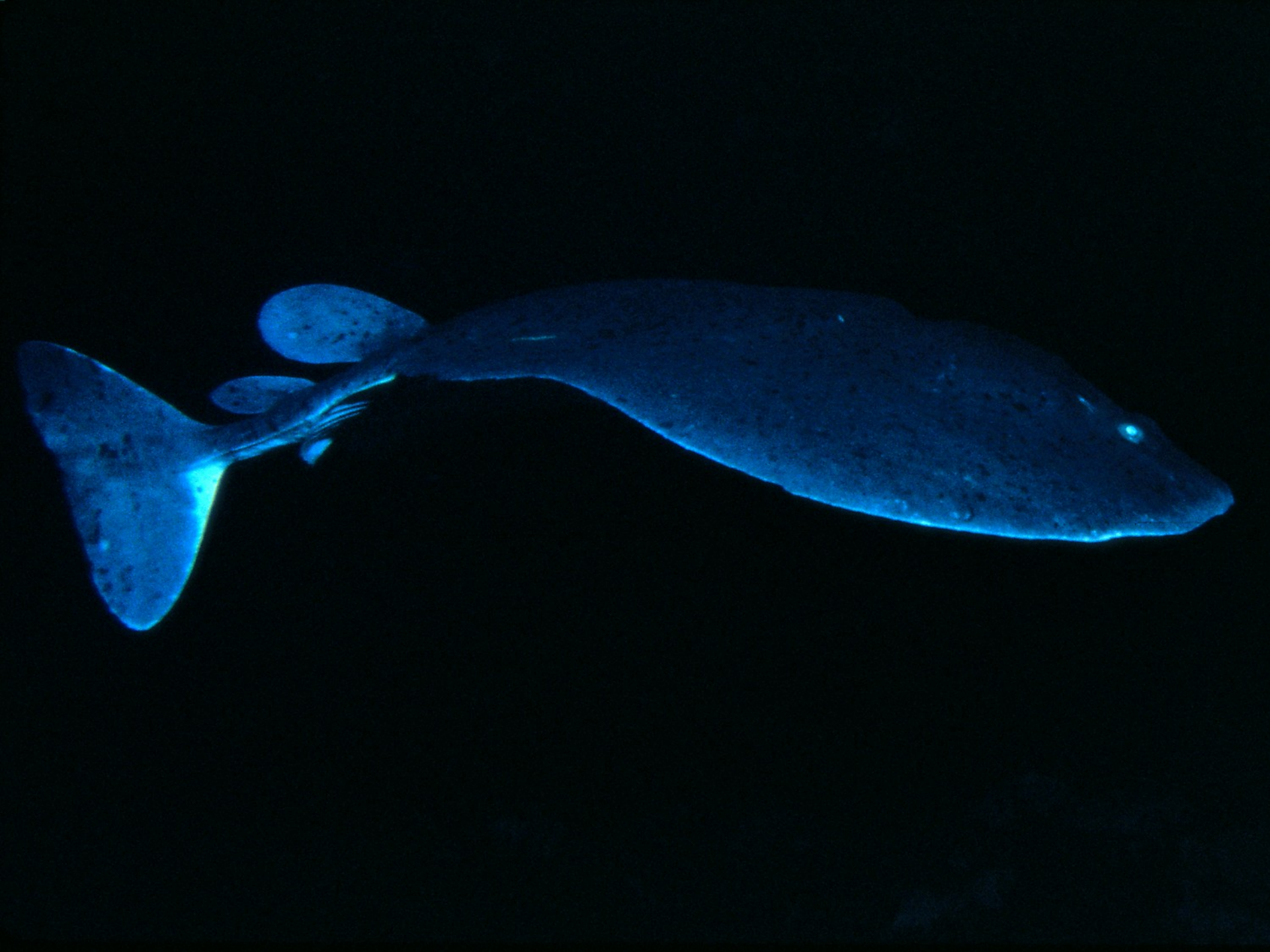


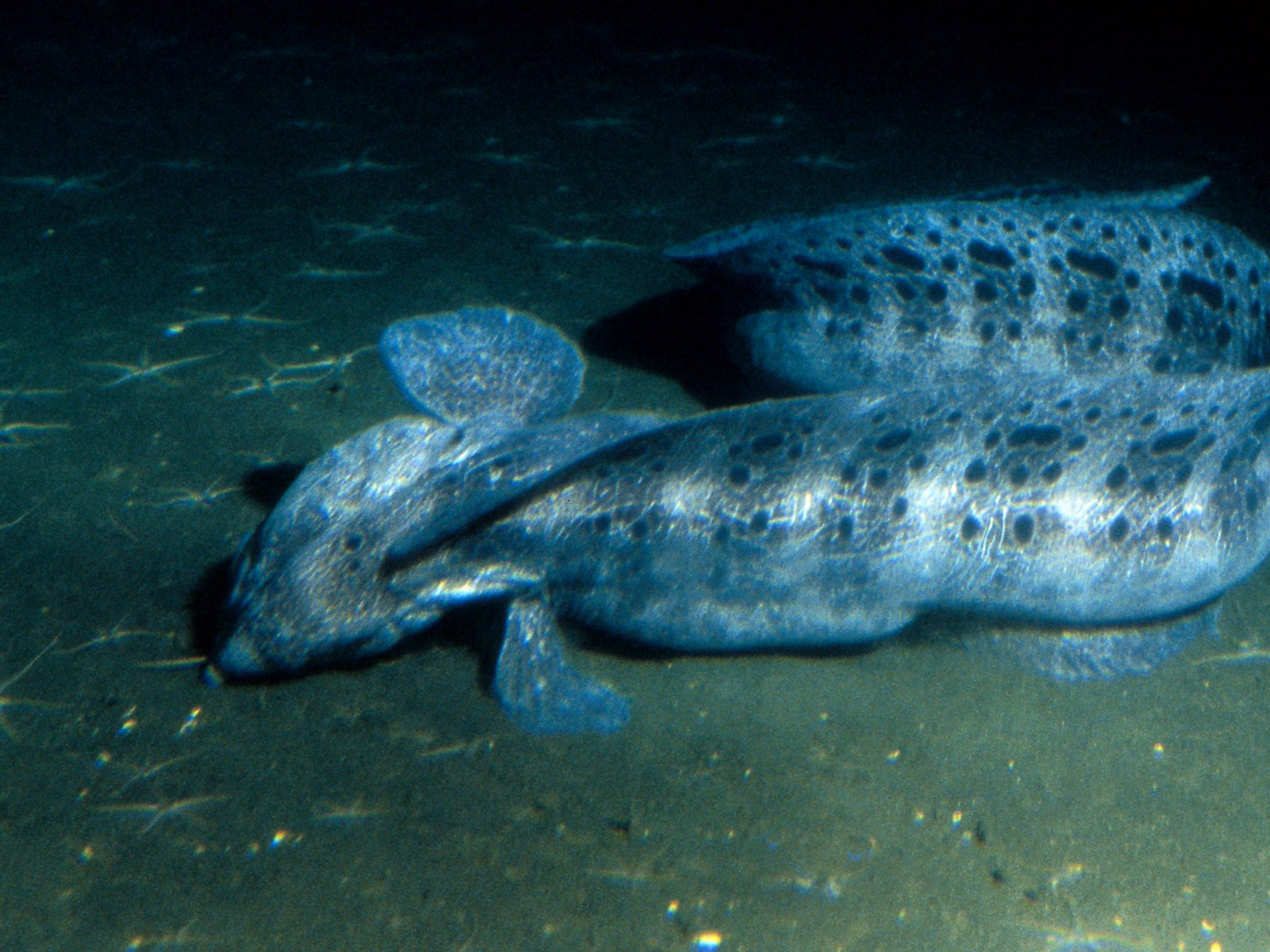
graph tell you?

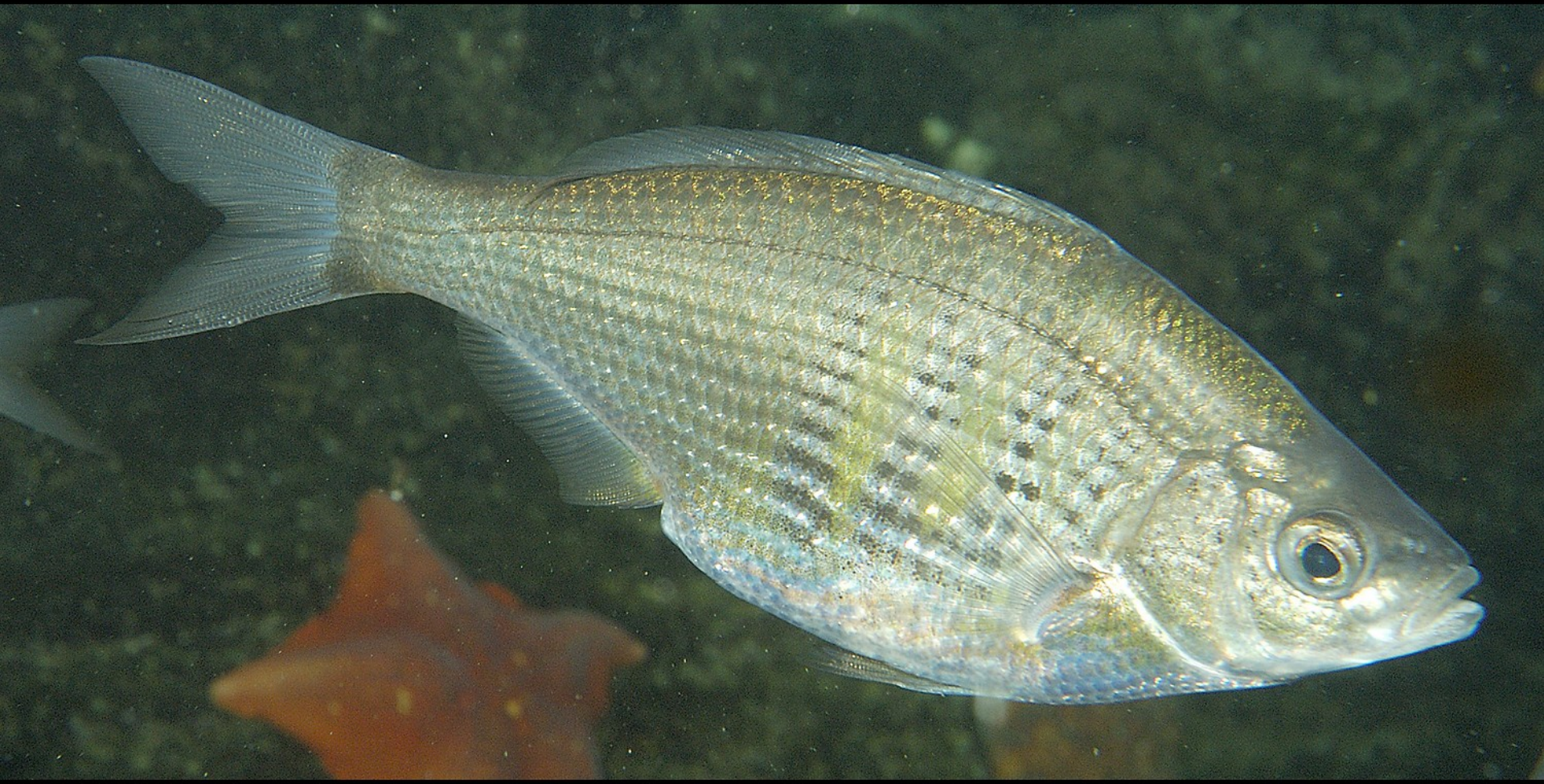
Now, let's look at some cool (mainly Californian) fish!!!

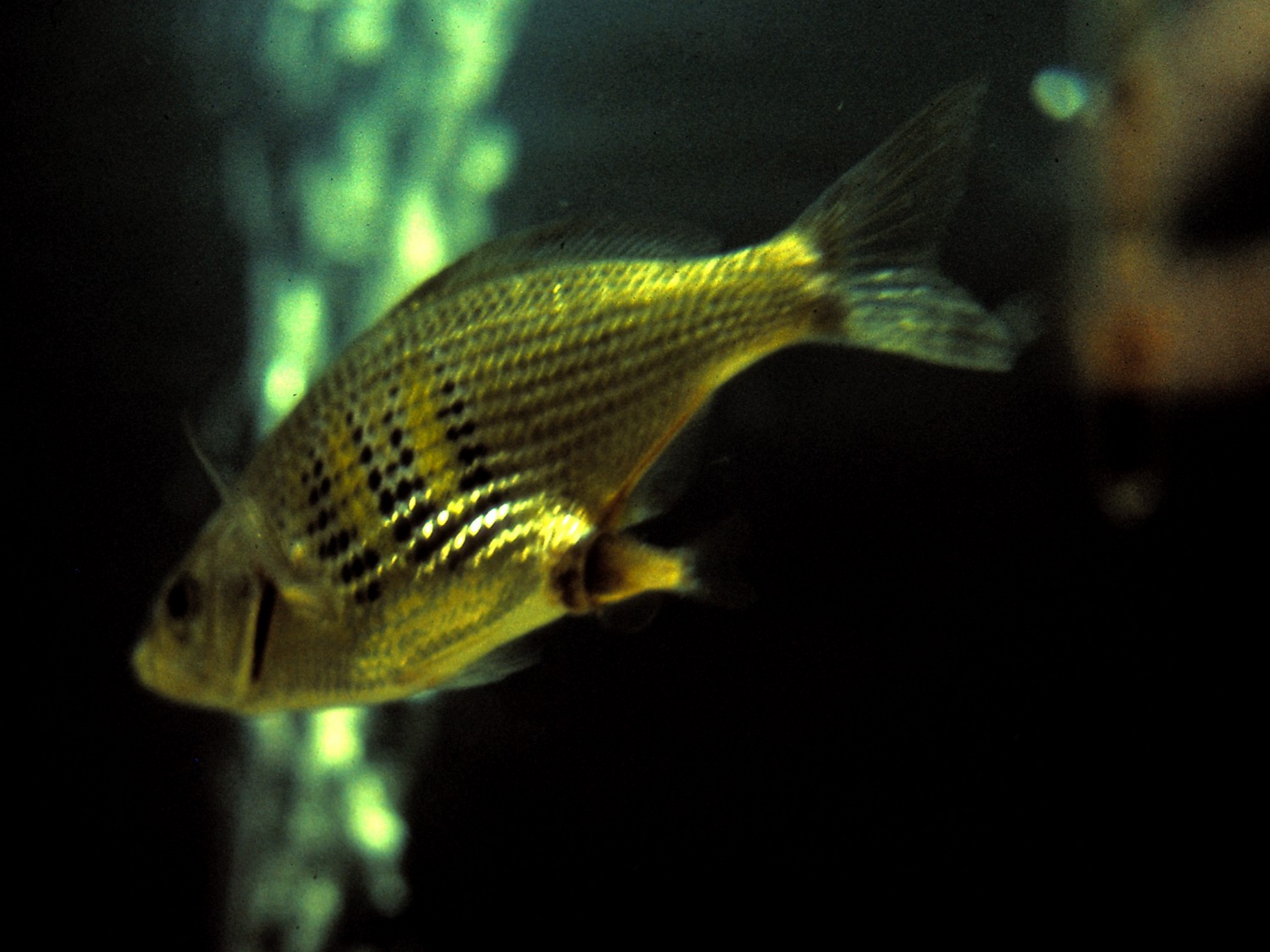


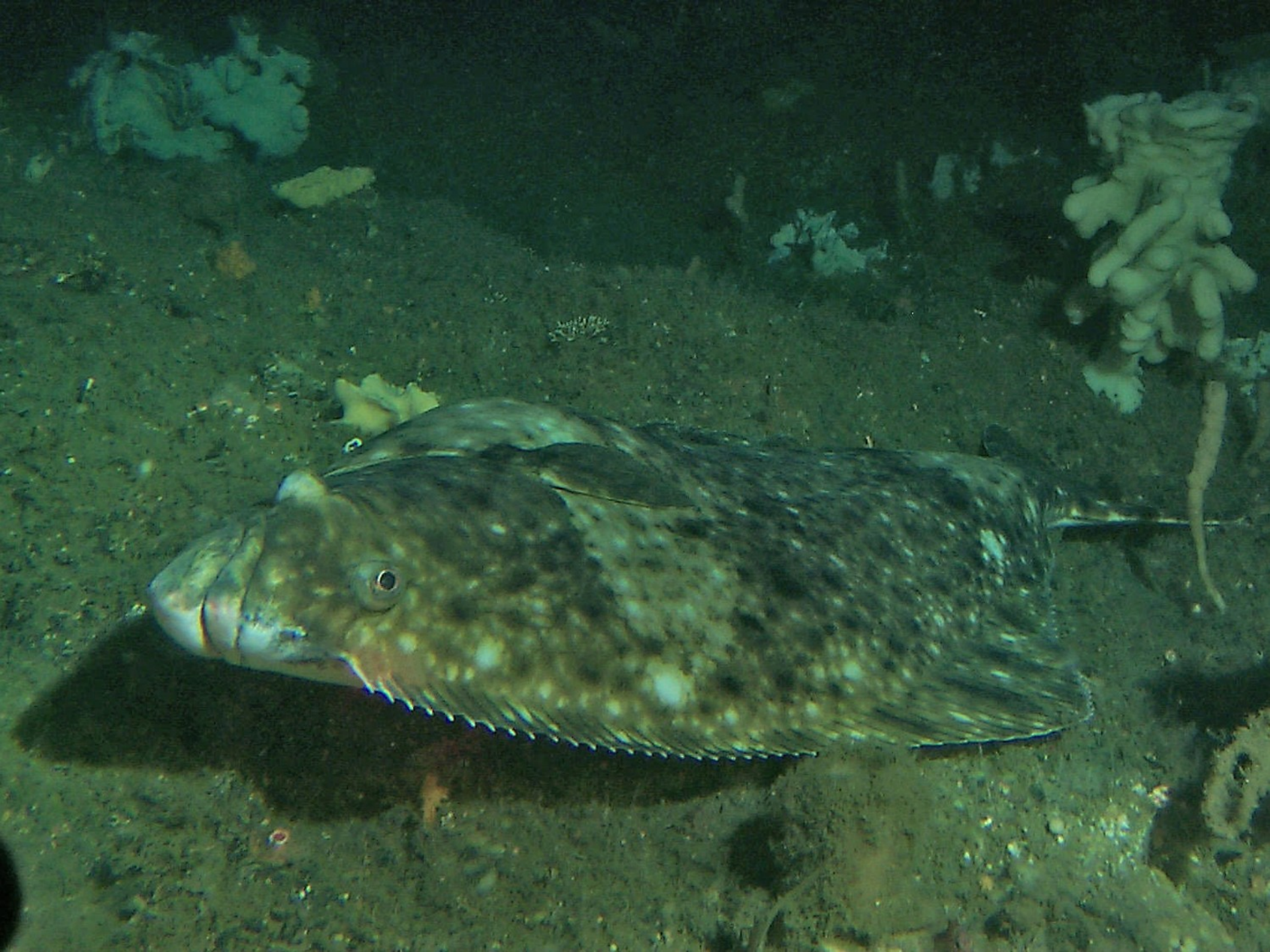


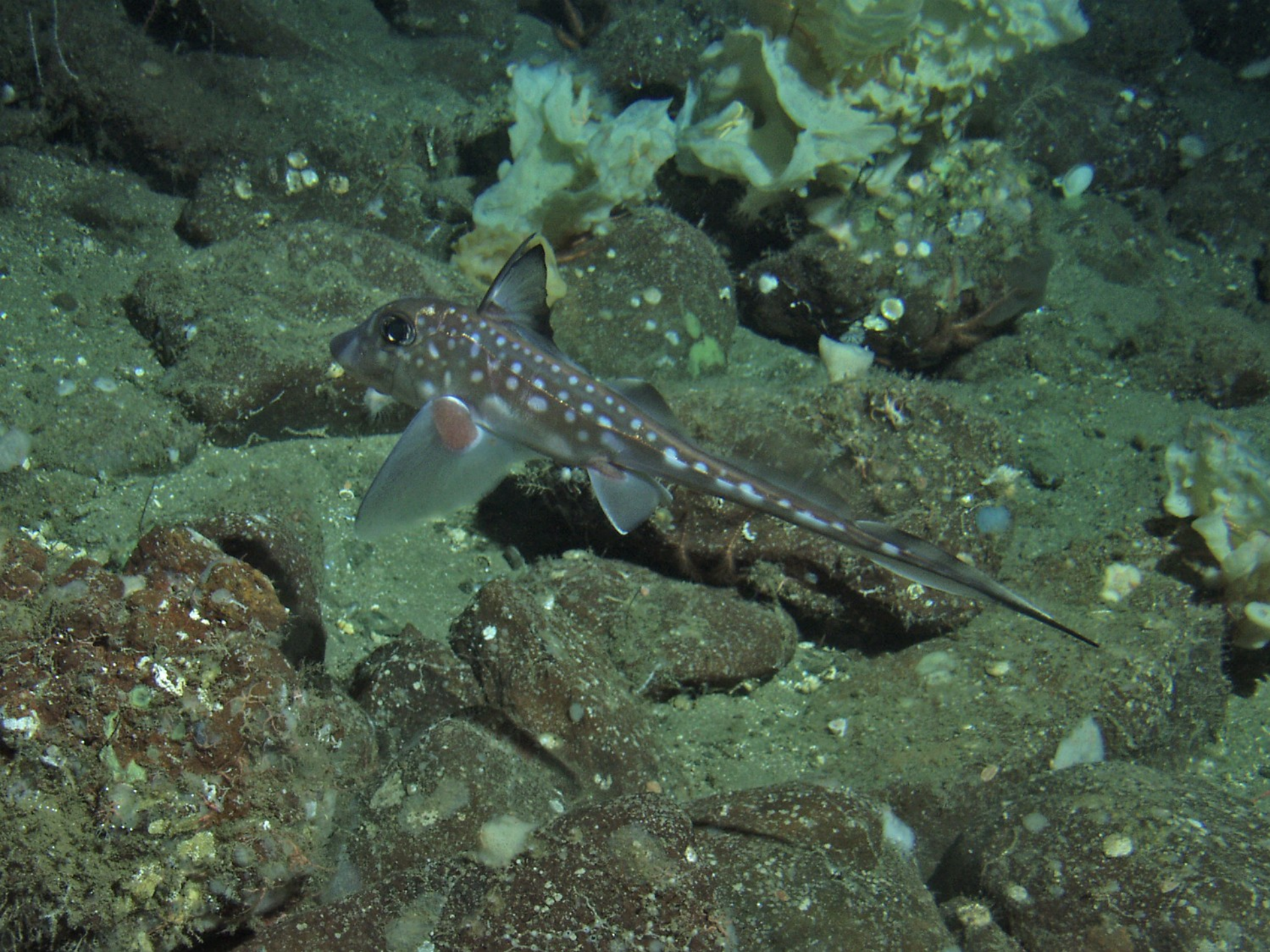


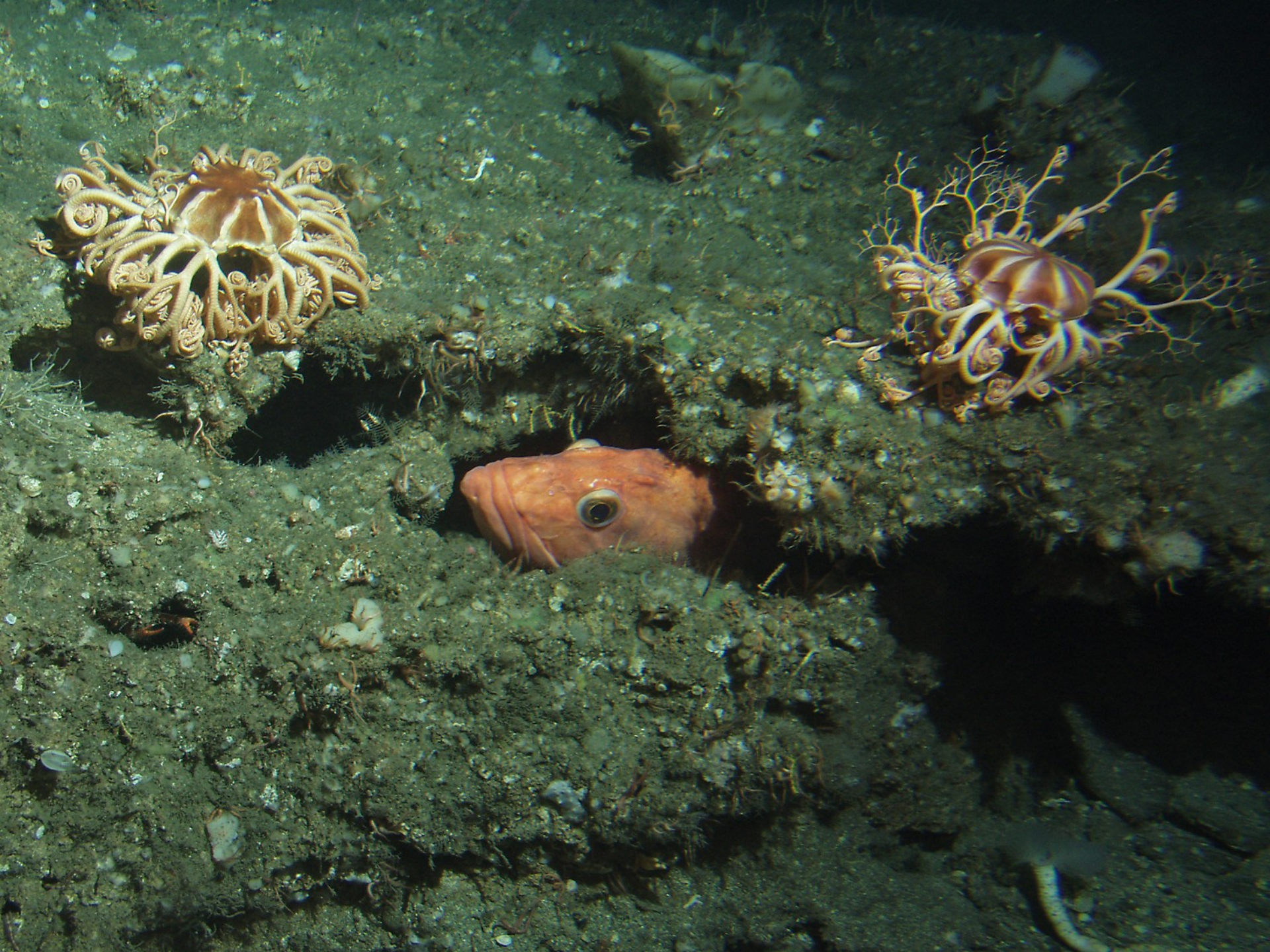












Oceanic Circulation

The Gulf Stream moderates temperatures in northwest Europe.

The Kuroshio is a warm-water current that brings tropical waters to southern islands of Japan.

The Oyashio is a cold-water current that cools northeast coast of Asia.

The Labrador Current cools maritime provinces of northeastern Canada.

Gulf of Alaska

Baltic Sea

North Sea

Black Sea

Sea of Okhotsk

Bering Sea

Sea of Japan

Mediterranean Sea

Gulf of Mexico

Gulf of California

Atlantic Ocean

Caribbean Sea

Red Sea

Persian Gulf

Arabian Sea

China Sea

Bay of Bengal

Pacific Ocean

Equator

Coral Sea

Indian Ocean

Tasman

The Humboldt Current brings cold Antarctic waters along west coast of South America.

The cold currents of the West Wind Drift circle Antarctica.

The Benguela Current cools waters off southwest Africa.

Palm trees in Britain???!!!

Oceans - Geography

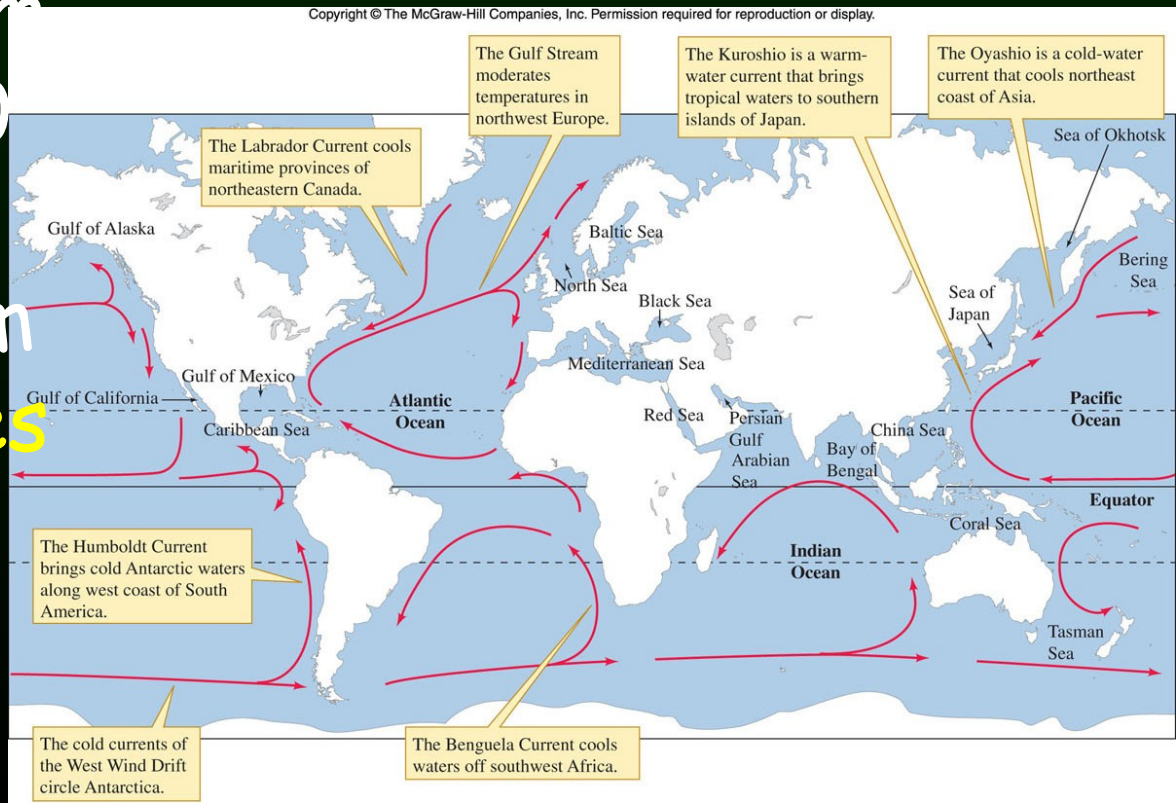
- The Pacific is the largest and deepest ocean
- The Atlantic is the second largest
- The Indian is the smallest

Average Depth

Pacific - 4,000 m
Atlantic - 3,900 m
Indian - 3,900 m

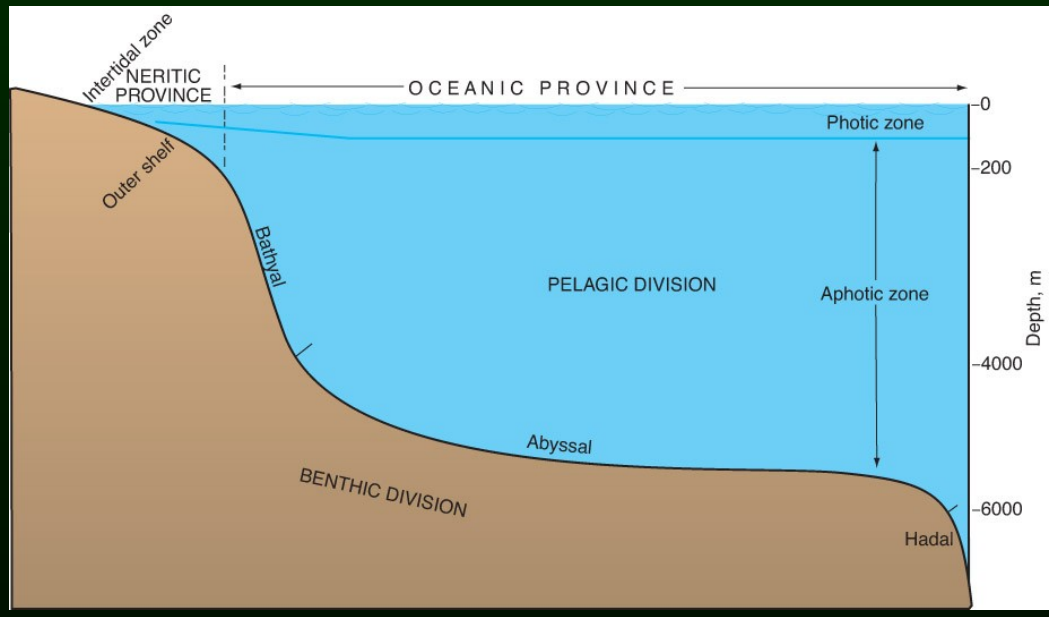
Undersea Trenches

Marianas - 10,000 m deep



Oceans - Structure

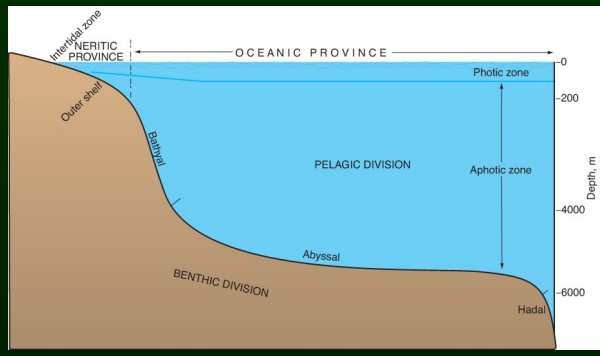
- Littoral Zone (intertidal zone): Shallow shoreline.
- Neritic Zone: Coast to margin of continental shelf.

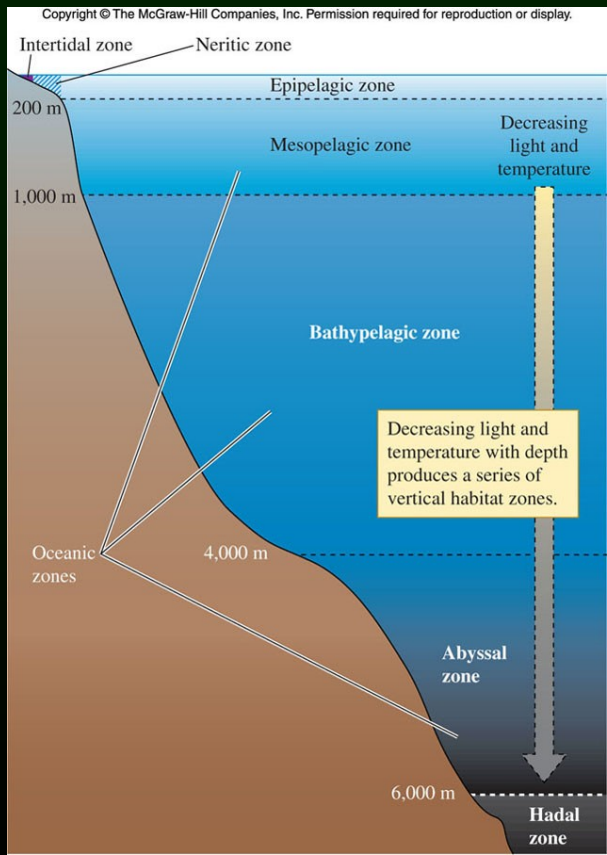


Oceanic Zone: Beyond continental shelf.

Oceans - Structure

- Oceanic Zone: Beyond continental shelf.
  - Epipelagic 0 - 200 m
  - Mesopelagic 200 - 1,000 m
  - Bathypelagic 1,000 - 4,000 m
  - Abyssal 4,000 - 6,000 m
  - Hadal 6,000 + m
- Benthic: Habitat on
- bottom of ocean.
- Pelagic: Habitat off the
- bottom of the ocean.

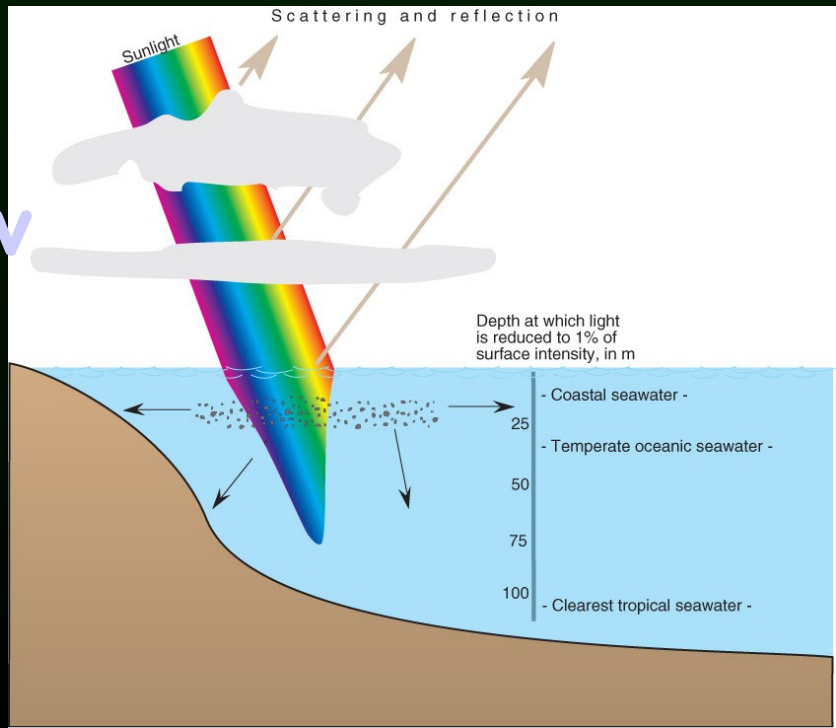




Oceans - Physical Conditions

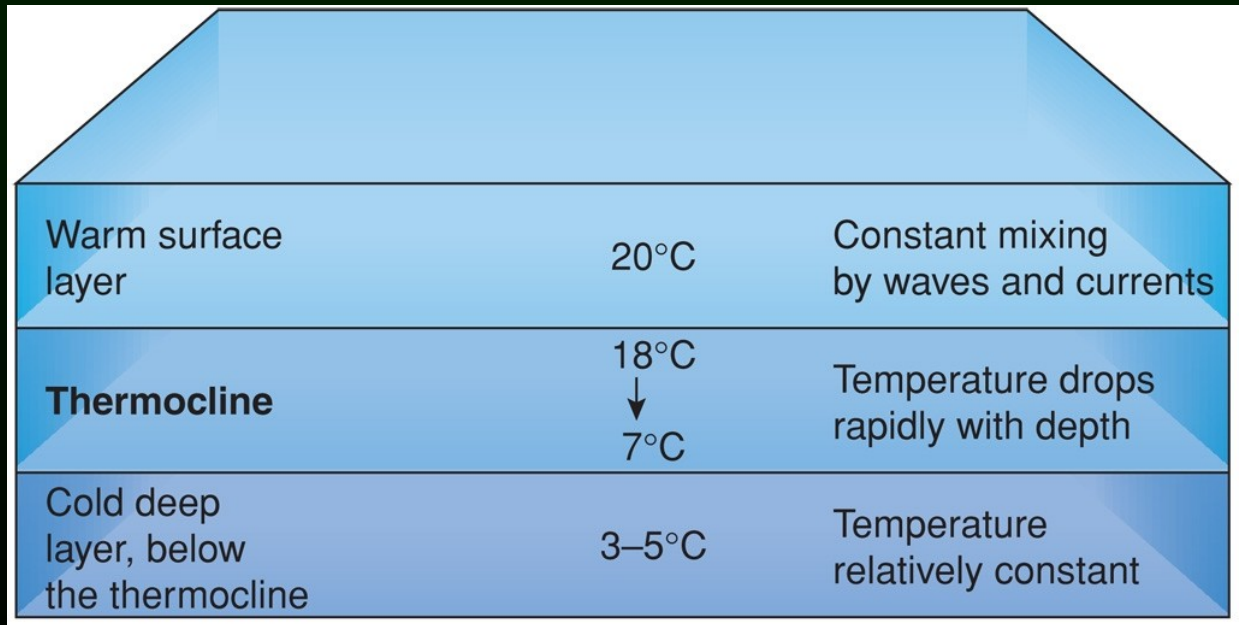
- Light
  - Approximately 80% of solar energy striking the ocean is absorbed in first 10 m.
    - Very little, if any penetrates past 600 m.
      - 3,400 m left with no light besides…

http://www.youtube.com/watch?v=T2xh9-UPSlU



Oceans - Physical Conditions

- Temperature – the ocean is layered based on density!
  - Density is determine by temperature & salinity
  - warm water floats on top of cooler water.
  - Thermocline: Layer of water through which temperature changes rapidly with depth.
    - Creates thermal stratification.



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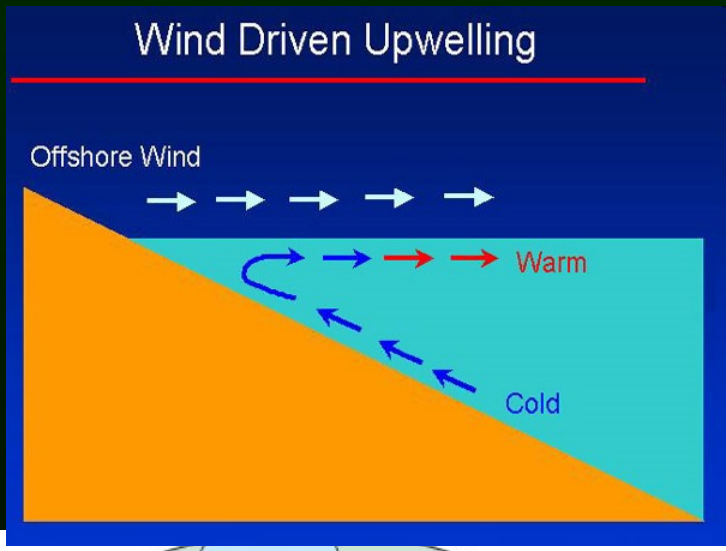
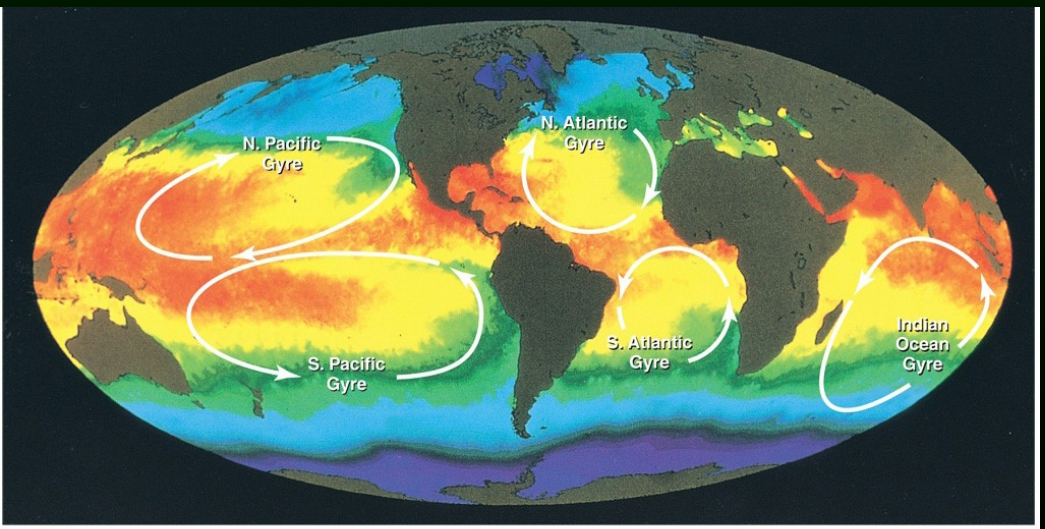
Oceans - Physical Conditions

- Water Movements
  - Wind-driven surface currents create gyres that move right in the Northern Hemisphere and left in the Southern Hemisphere
  - Deepwater currents and wind cause upwelling.





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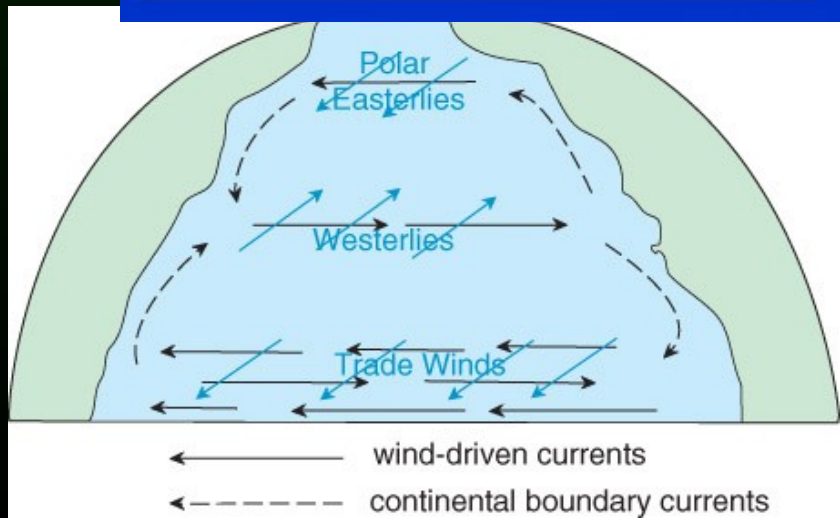
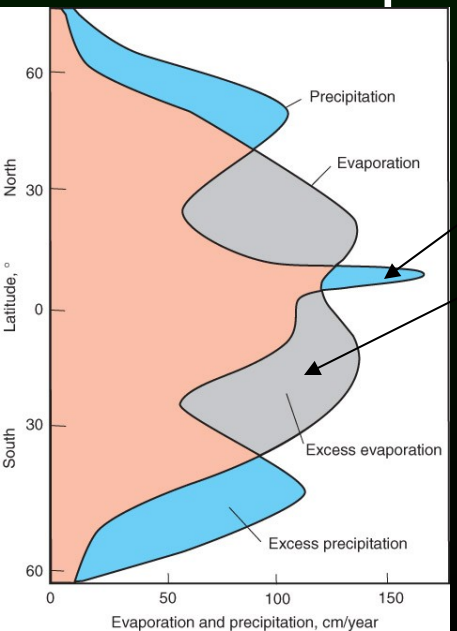
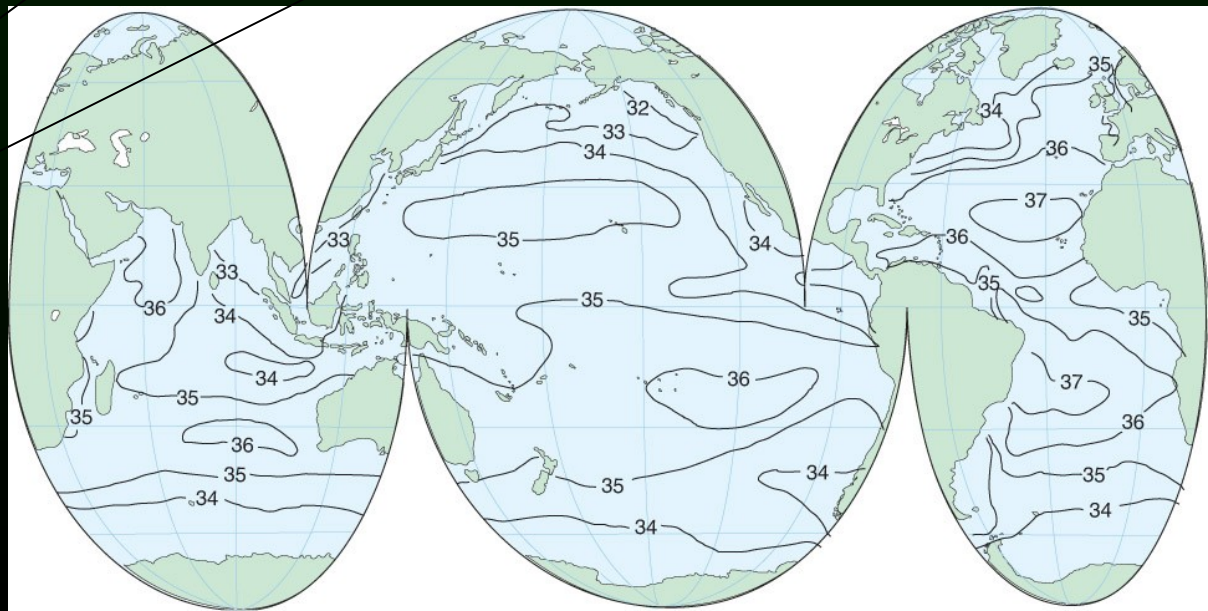


Oceans - Chemical Conditions

- Salinity
  - In the open ocean, salinity varies from about 34 ppt to 36.5 ppt.
    - Lowest salinity occurs near equator where precipitation exceeds evaporation.
    - Highest salinity occurs in subtropics where evaporation exceeds precipitation.

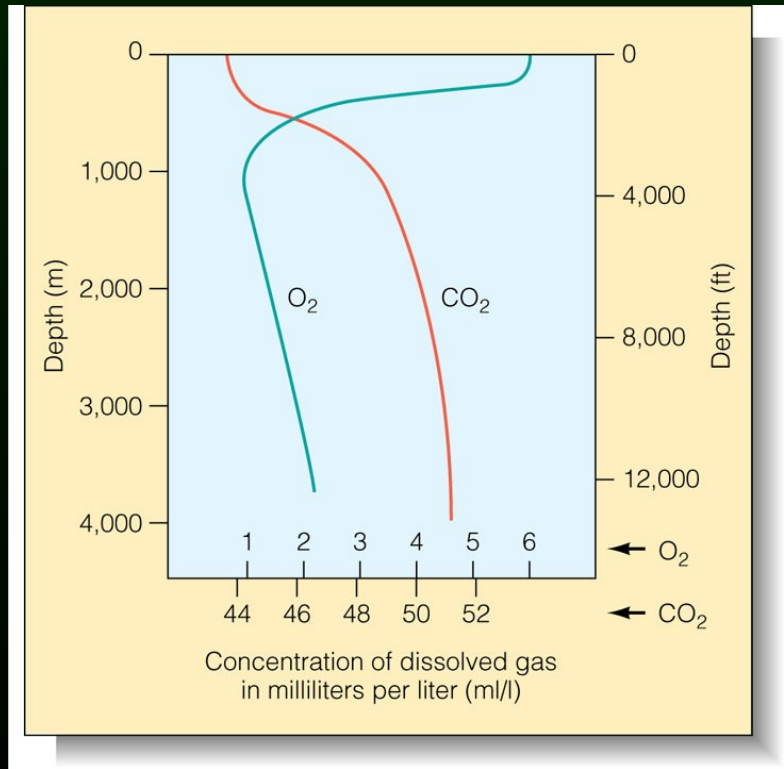




Oceans - Chemical Conditions

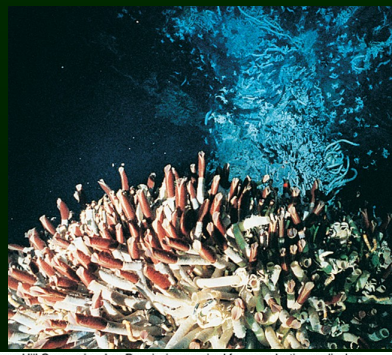
- Oxygen
  - A liter of air = 200 ml of oxygen at sea level
  - a liter of seawater = 9 ml of oxygen.
    - concentration decreases with depth.
      - Minimum usually < 1,000m.

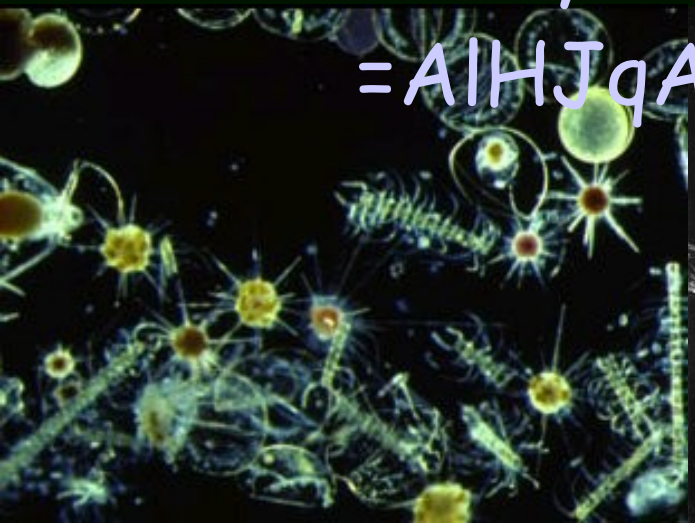
Why does CO_2 increase?
Why does O_2 decrease?

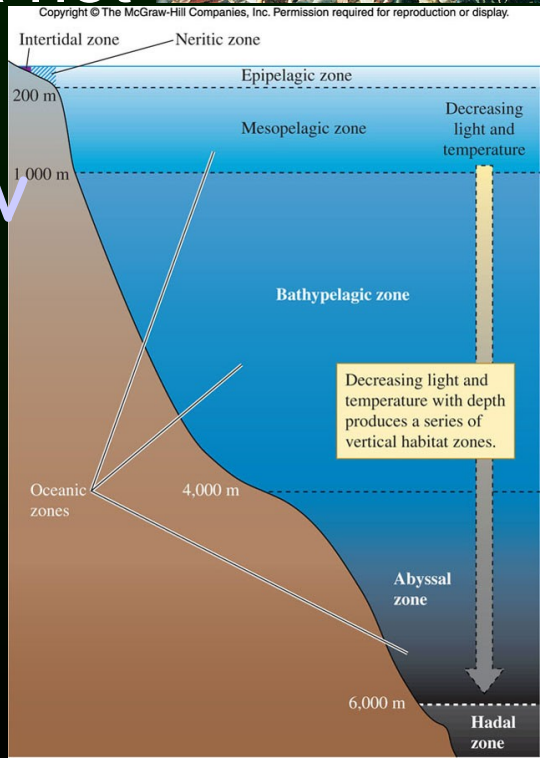


Oceans - Biology

- Photosynthetic organisms are limited to upper epipelagic zone (photic zone).
  - Phytoplankton and zooplankton.
  - Due to size, oceans contribute ¼ of total photosynthesis in the biosphere.
- Chemosynthesis occurs near undersea hot springs.http://www.youtube.com/watch?v=AlHJqA8YkoI



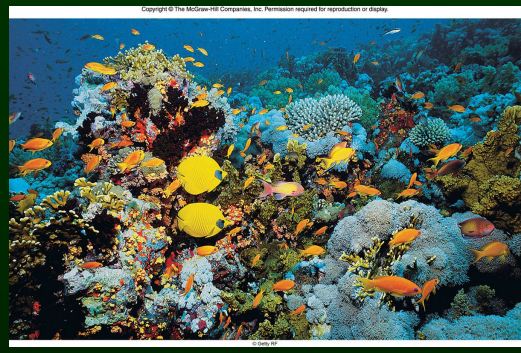




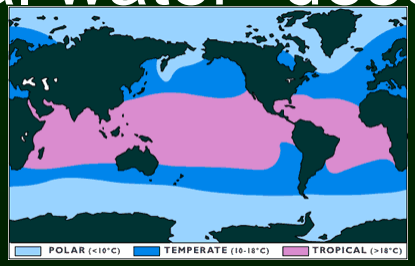
Oceans - Human Influences

- For most of human history, vastness of oceans has acted as a buffer against human intrusion.
- New human-induced threats:
  - Overharvesting
  - Dumping
  - Oil spills

Shallow Marine Waters – Coral Reefs



- Extremely productive & diverse!
- Islands in the tropical water "desert"
- Reef Categories
  - Fringing reefs:
  - Barrier reefs: Stands between open sea and lagoon.
  - Atolls:



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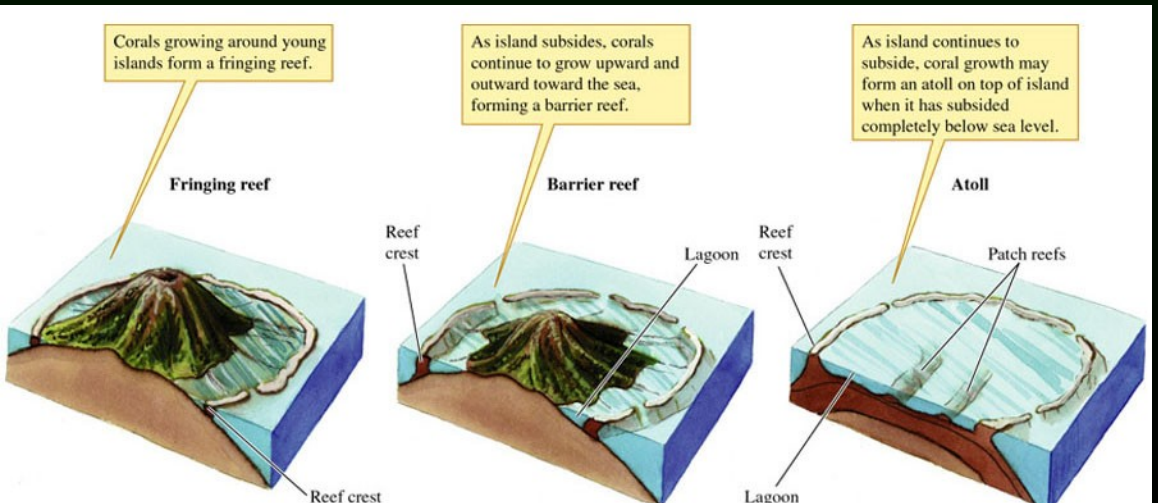
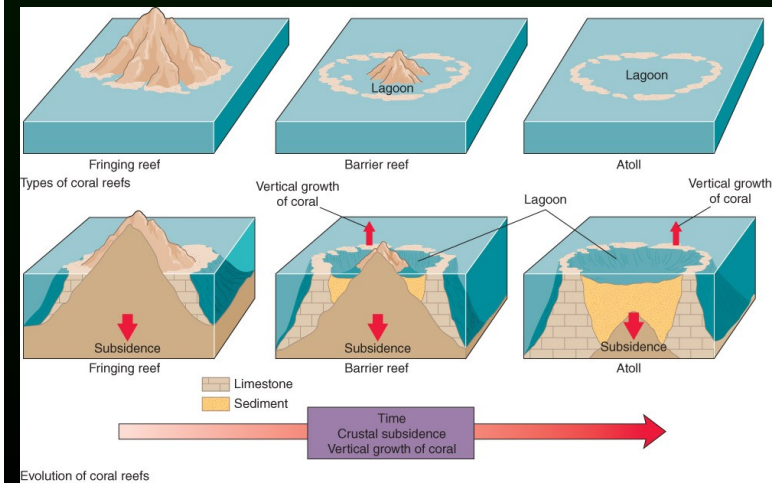




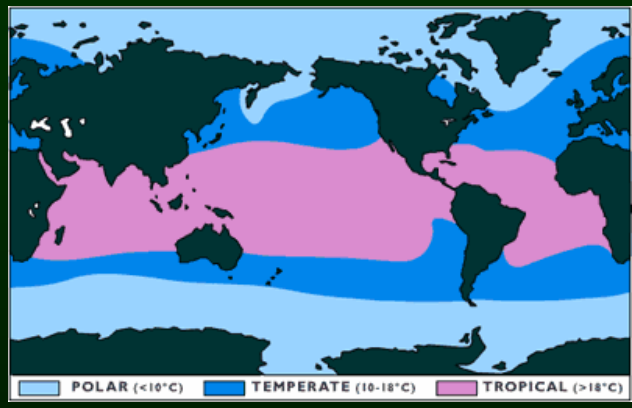
Shallow Marine Waters – Kelp Forests

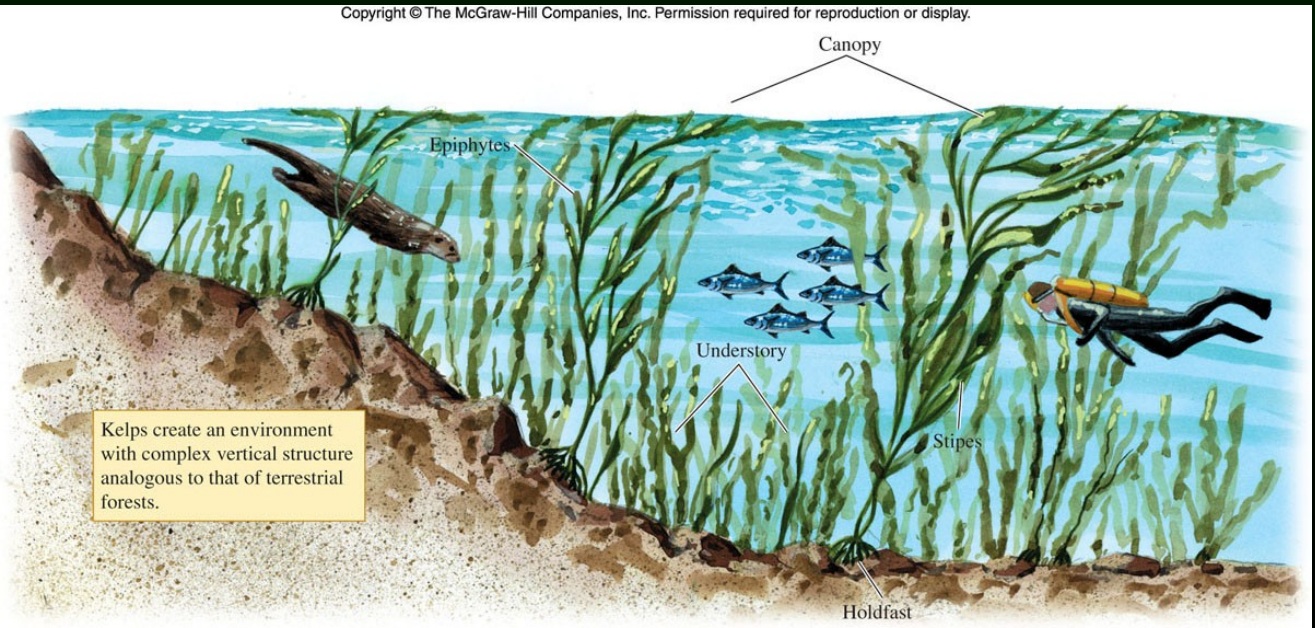
Very productive and diverse!

Structure similar to terrestrial forests.

Found in temperate waters

Canopy at water's surface.

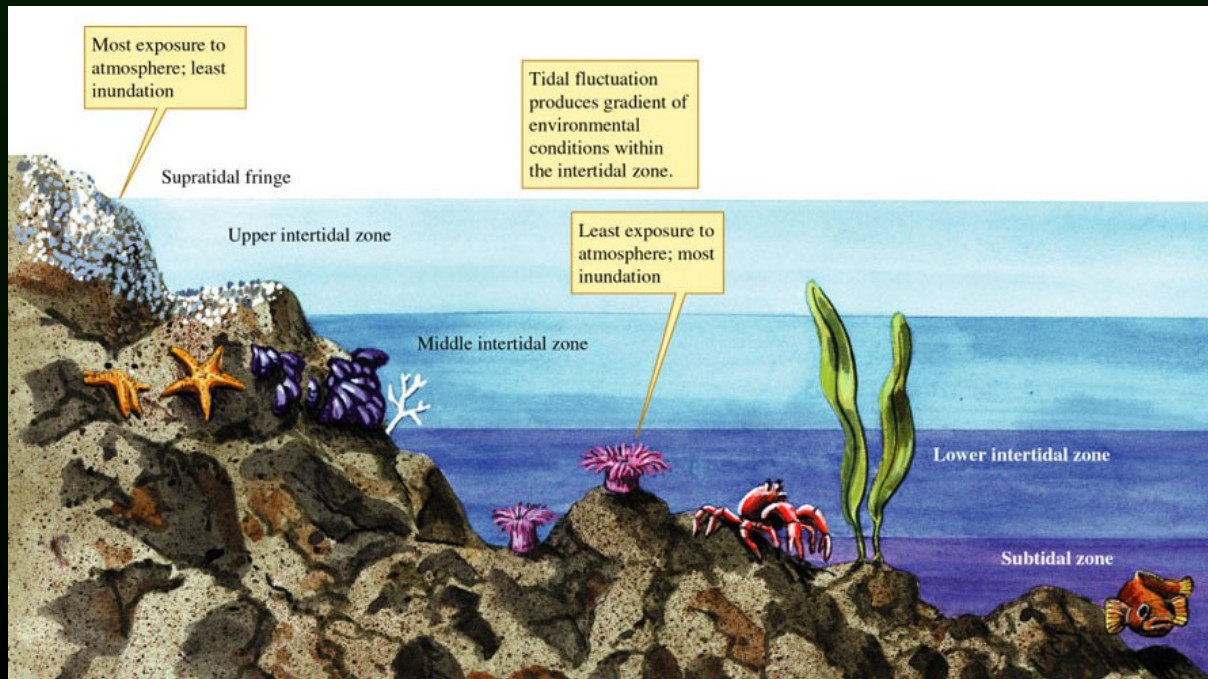




Marine Shores

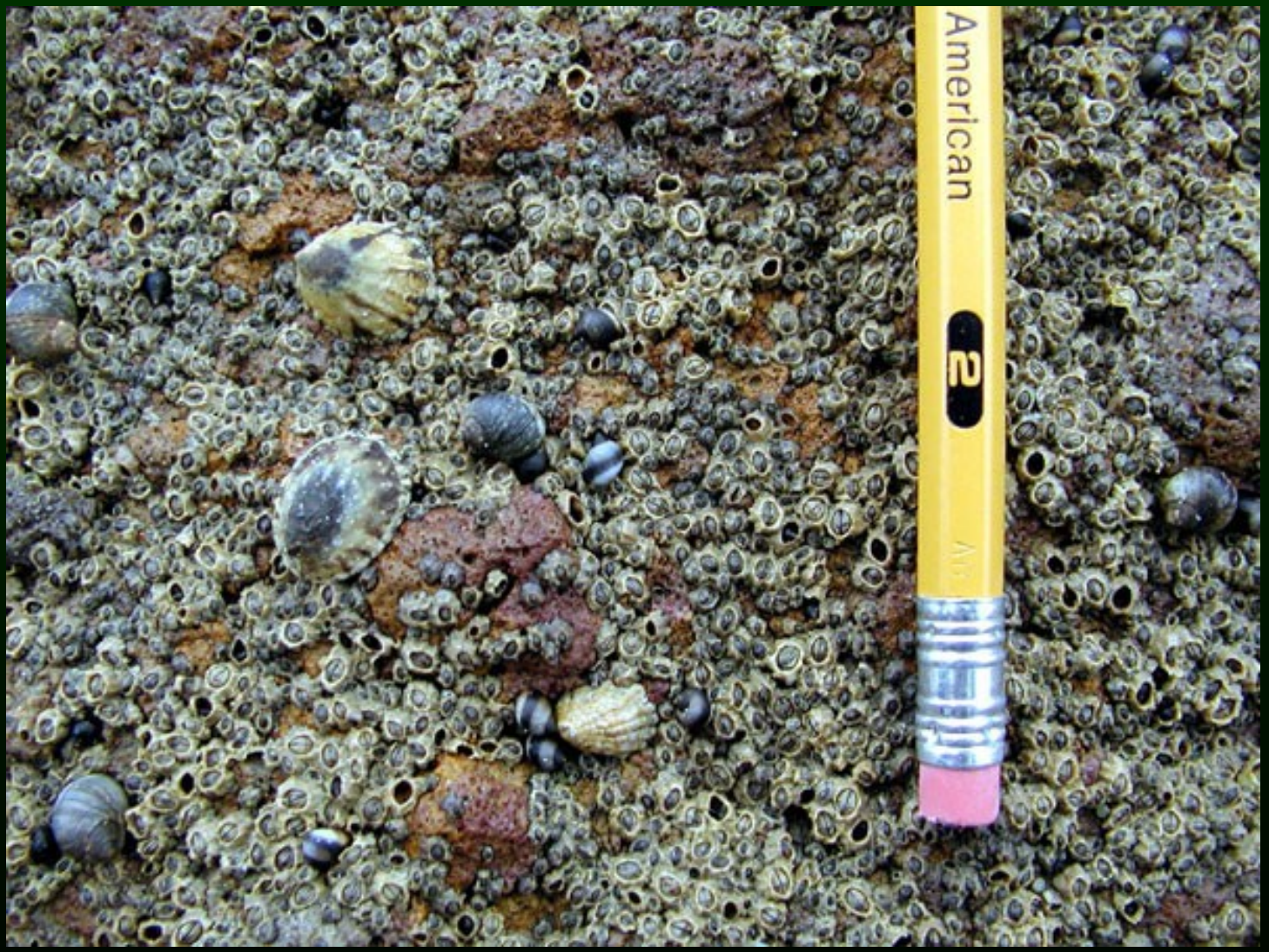
- Intertidal (littoral) Zone can be divided vertically:
  - Upper Intertidal: Covered only during highest tides.
  - Mid Intertidal
  - Lower Intertidal: Uncovered during lowest tides.
  - Subtidal: Covered by water even during lowest tides.

Intertidal Zonation – let's look at some cool California intertidal orgs!



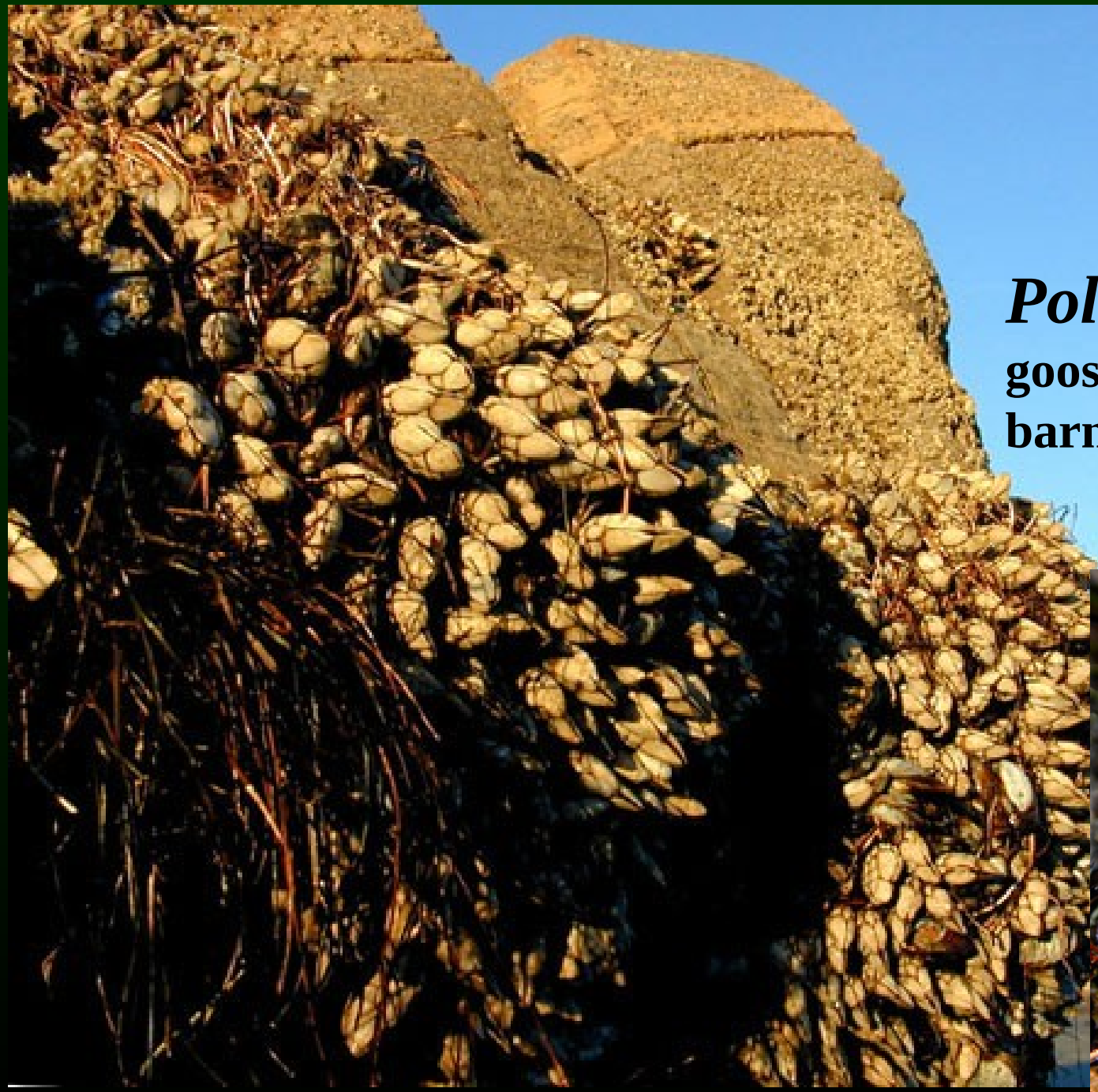
Littorina

Following the mucus trail to paradise…or a good friendship!!!



Chthamalus

Balanus



Pollicipes **– the gooseneck or leaf barnacle**


Mytilus


Anthopleura –

Why aren't their tentacles out?

Why do they have bits of shell on them?

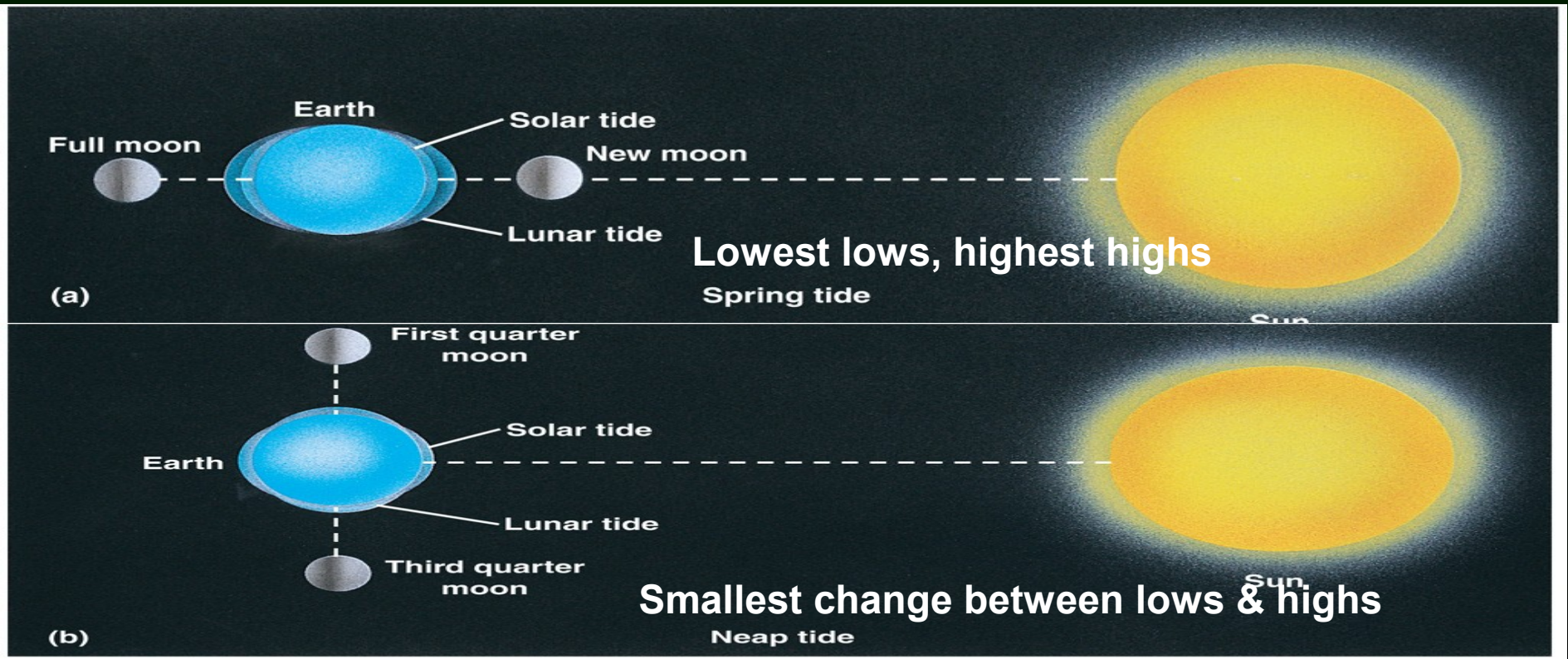

acrorhagi

Intertidal Communities

Pisaster

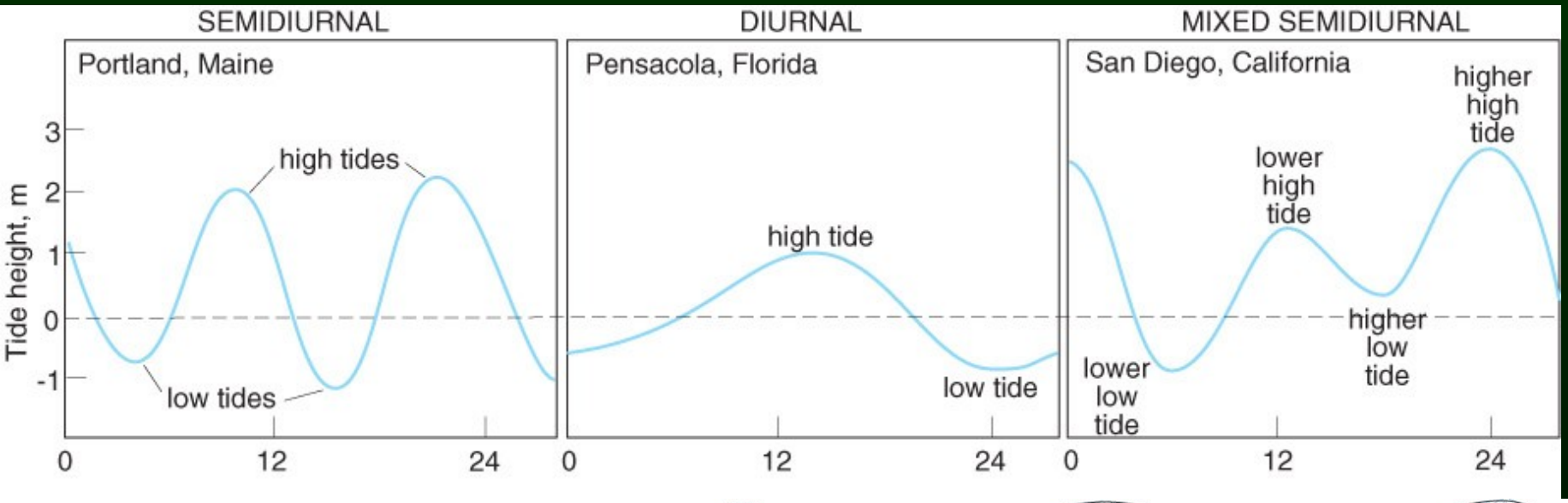
The Ocean in Motion - Tides

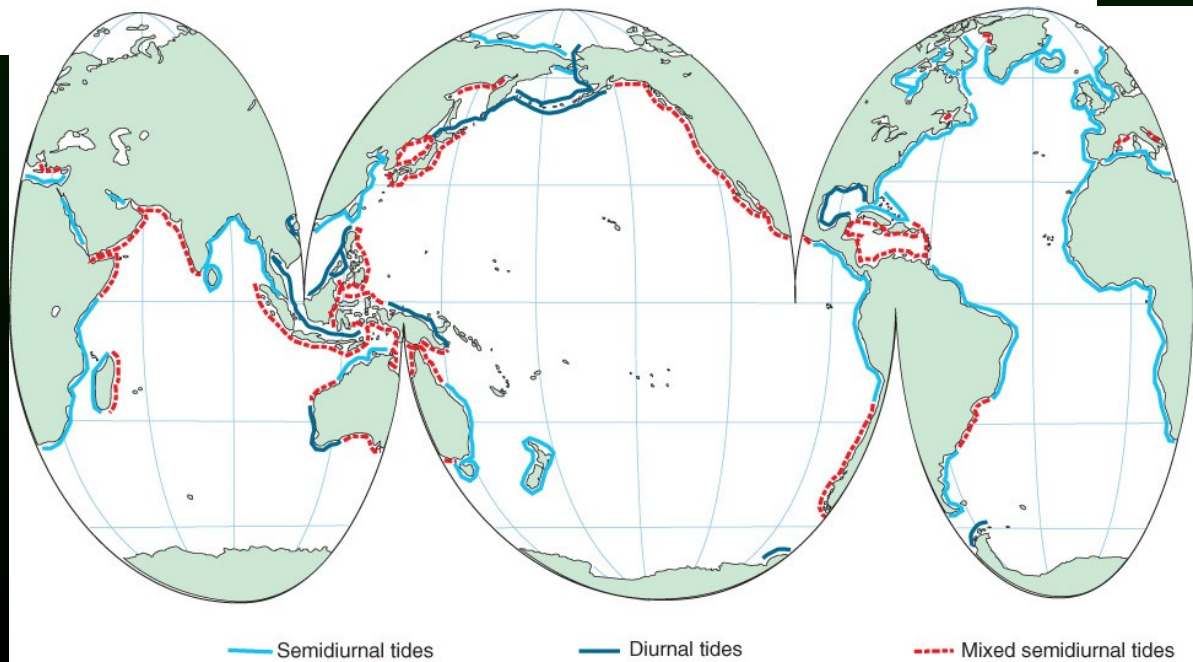
- Tides are the periodic changes in water level that occur along coastlines.
- They are a result of the gravitational pull of the moon and the sun on the water of the oceans.



The Ocean in Motion

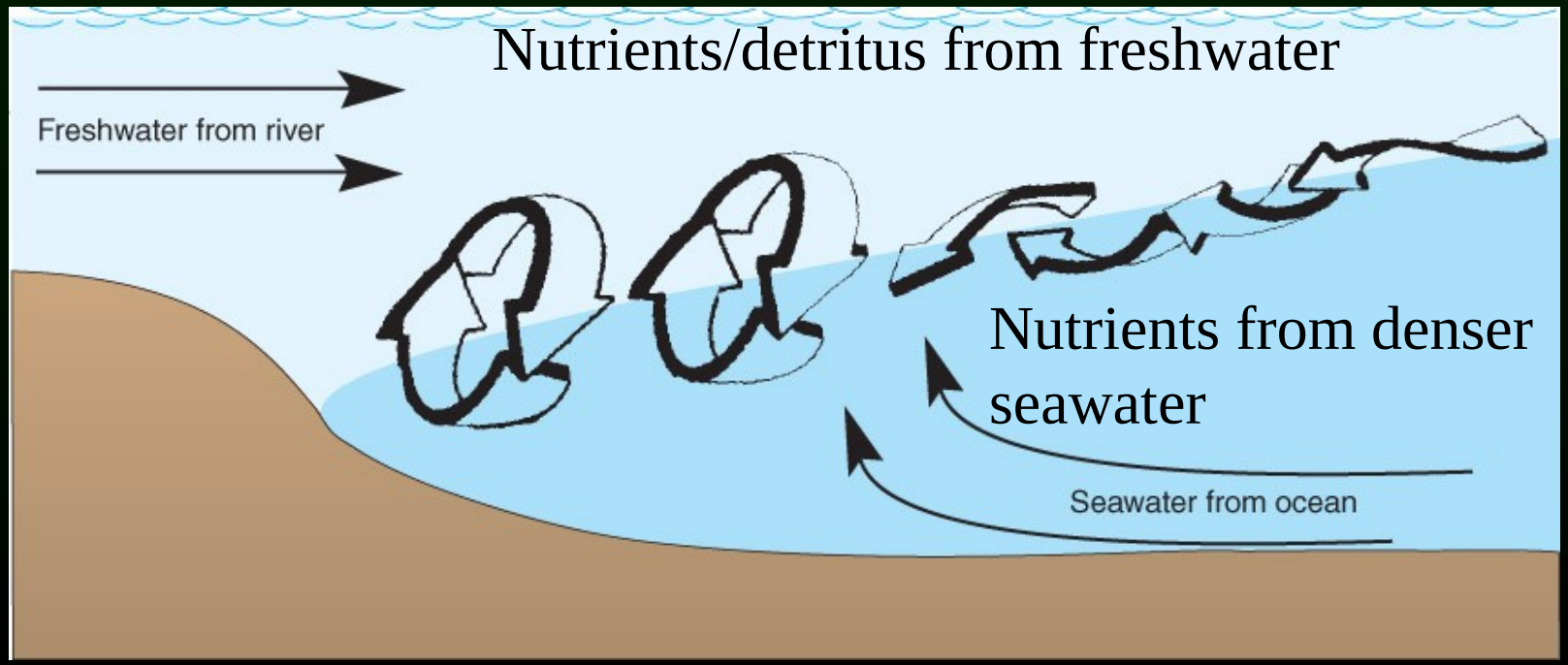
Ocean Tides



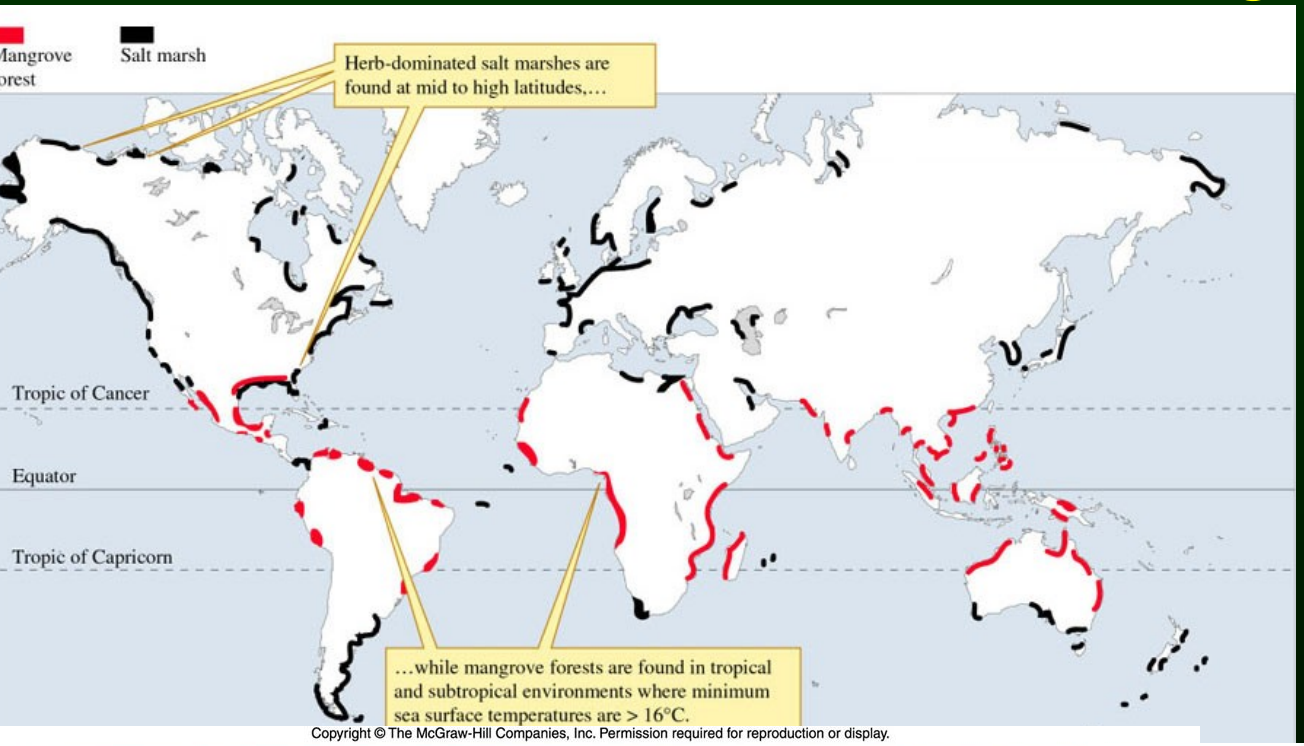


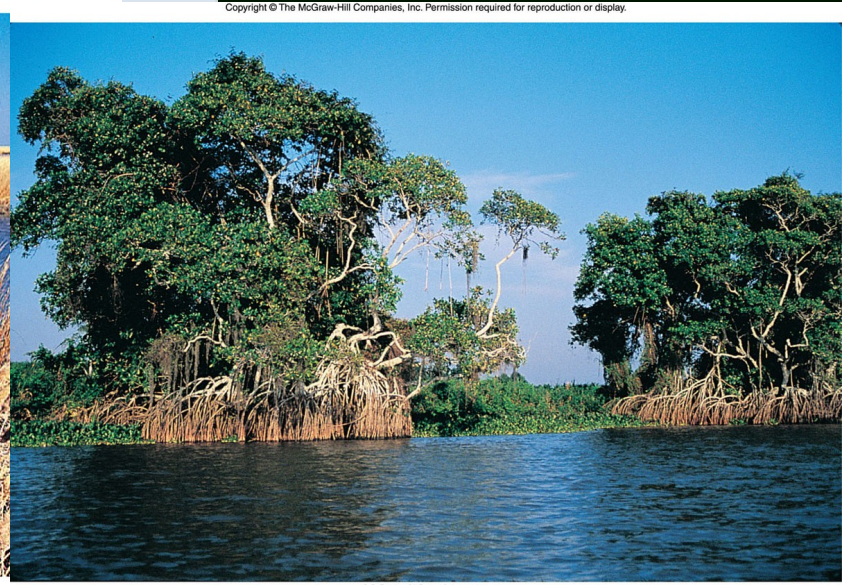
Estuaries, Salt Marshes, and Mangrove Forests

- Estuaries are found where rivers meet the sea.
- Salt Marshes (temperate) and Mangrove Forests (tropics) are concentrated along low-lying coasts
  - Extremely vulnerable to human intrusion
  - Very productive – lot of upwelling/detritus from on-land plant life



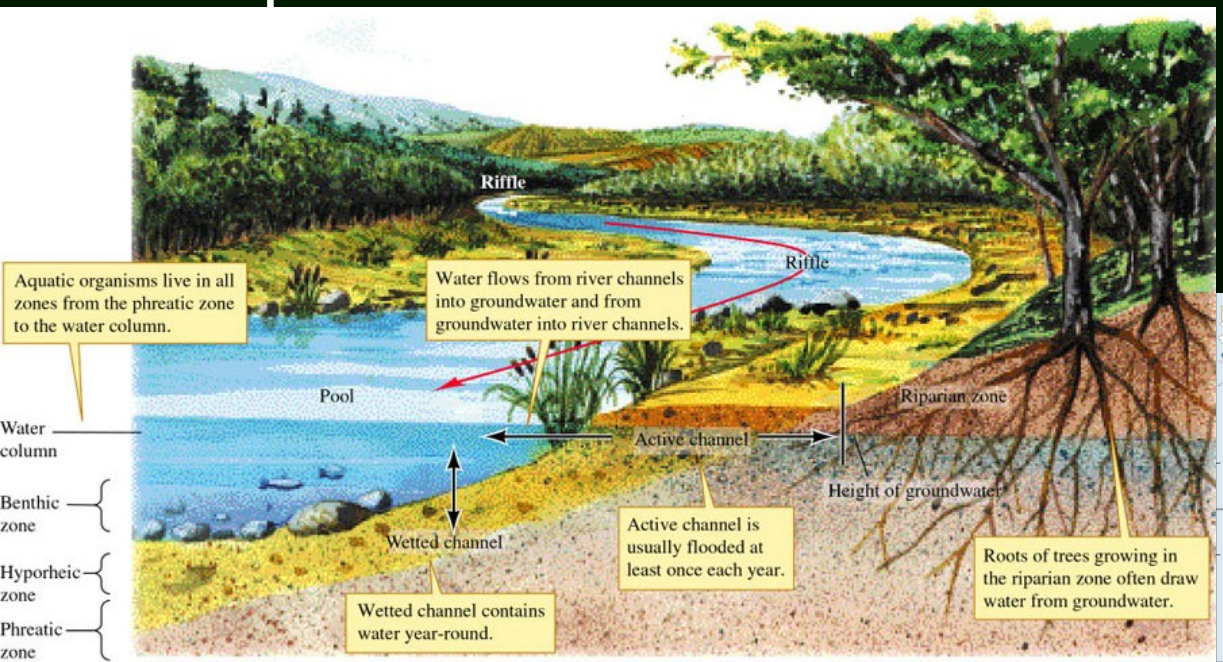
Salt Marshes & Mangroves





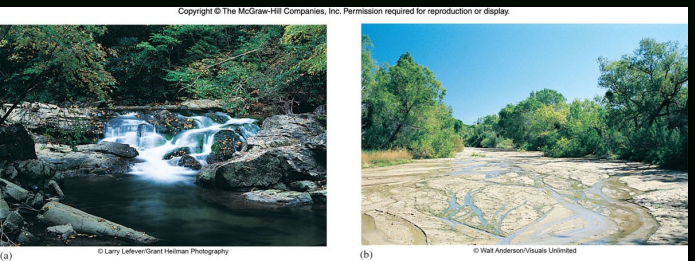
Freshwater: Rivers and Streams

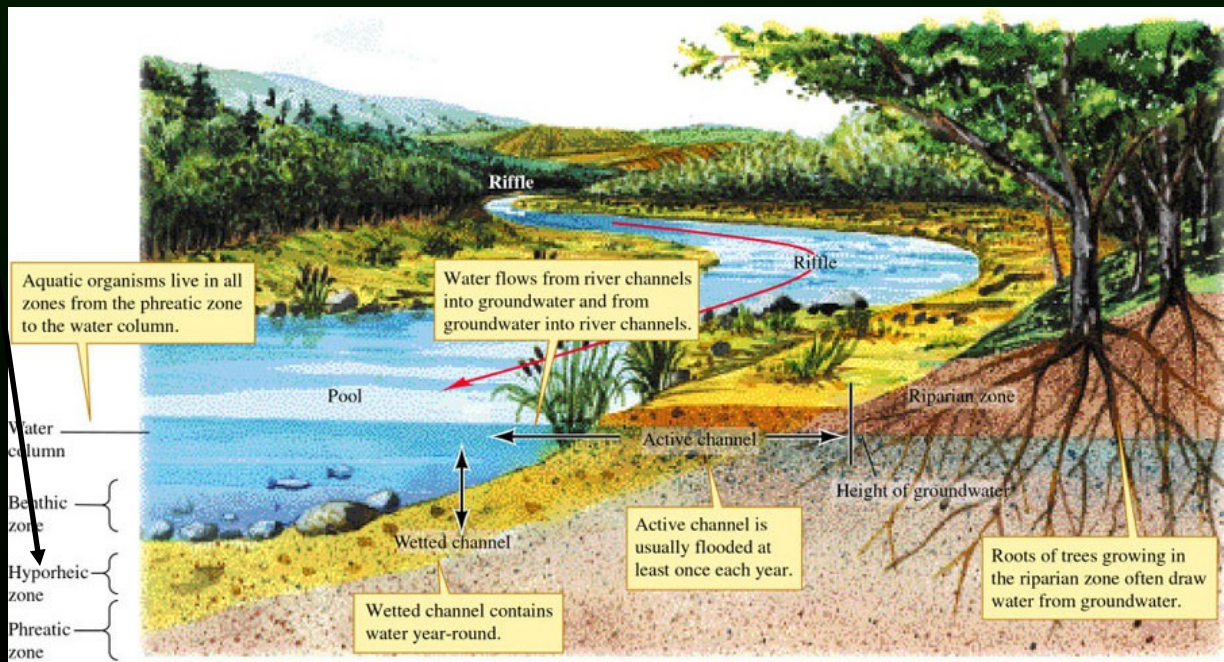
- Rivers and streams can be divided along three dimensions:
  - Length: Pools, runs, riffles, rapids
  - Width : Wetted / active channels
  - Vertical: Water surface, column and bottom (benthic)
- Riparian zone is a transition area between the aquatic and upland terrestrial environments.



Rivers and Streams

- Hyporheic Zone: Transition between surface water and groundwater.
  - Phreatic Zone: Groundwater
- Stream Order
  - First Order - Headwater
  - Second Order - Joining of two first order.
  - Third Order - Joining of two second order.





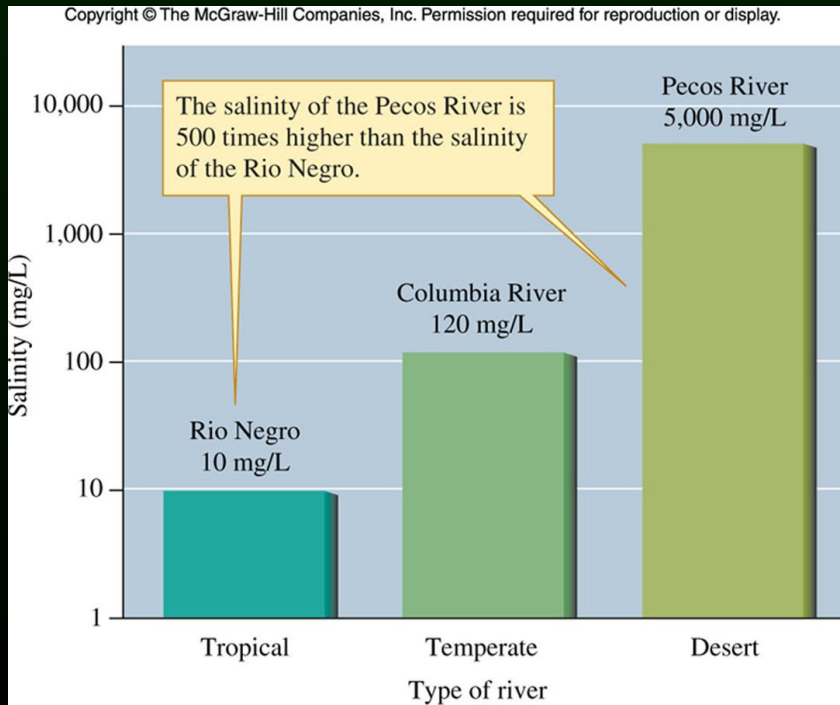
Rivers and Streams - Physical & Chemical Conditions

- Light
- Water Movements
- Temperature – close to air temp
- Salinity – highest in deserts; lowest in tropics
- Oxygen – usually not limiting in rivers

Human Influence

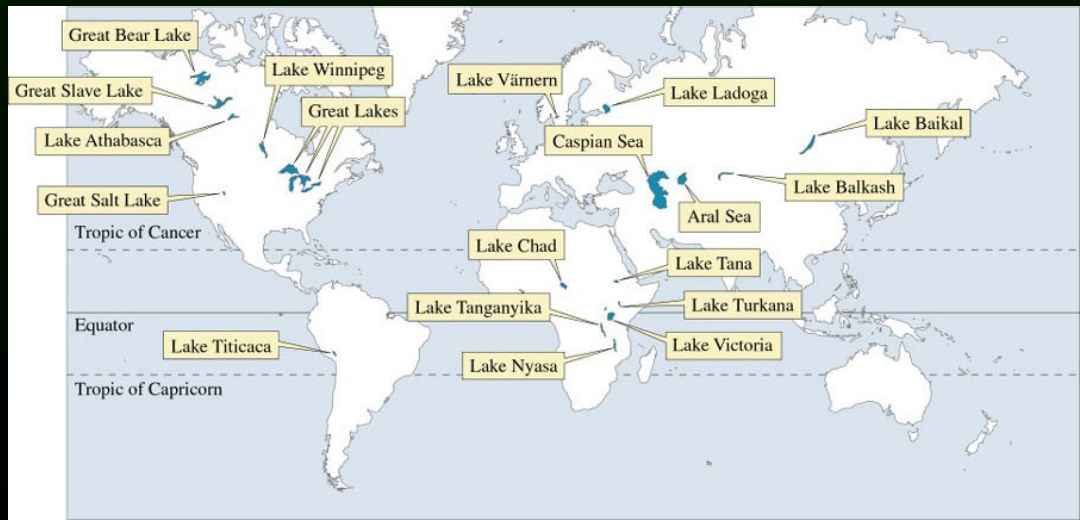
Long, intense history of human use.

Transportation, Irrigation, Waste



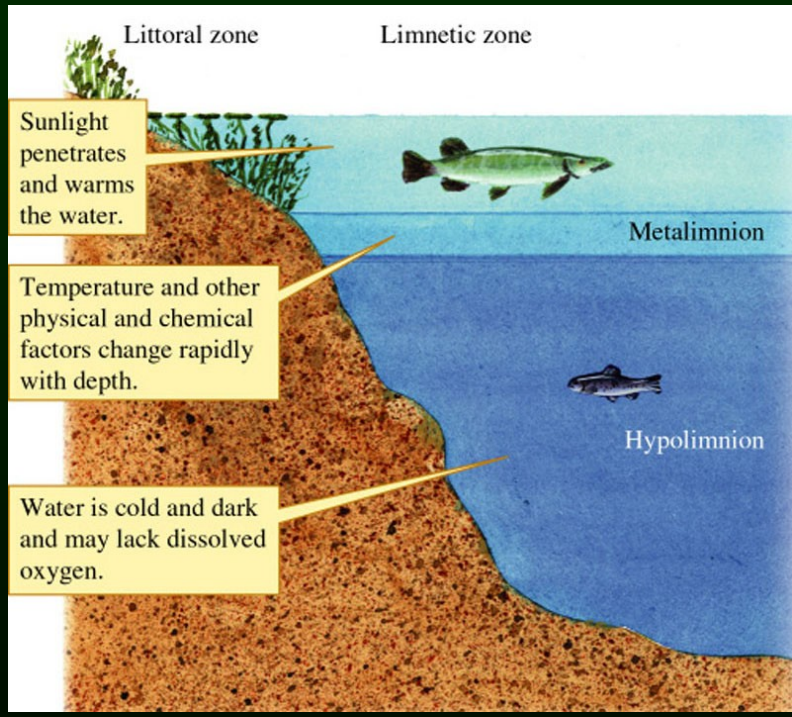
Lakes

- Most of the world's freshwater resides in a few large lakes.
  - Great Lakes of North America contain 20% of freshwater in the world.

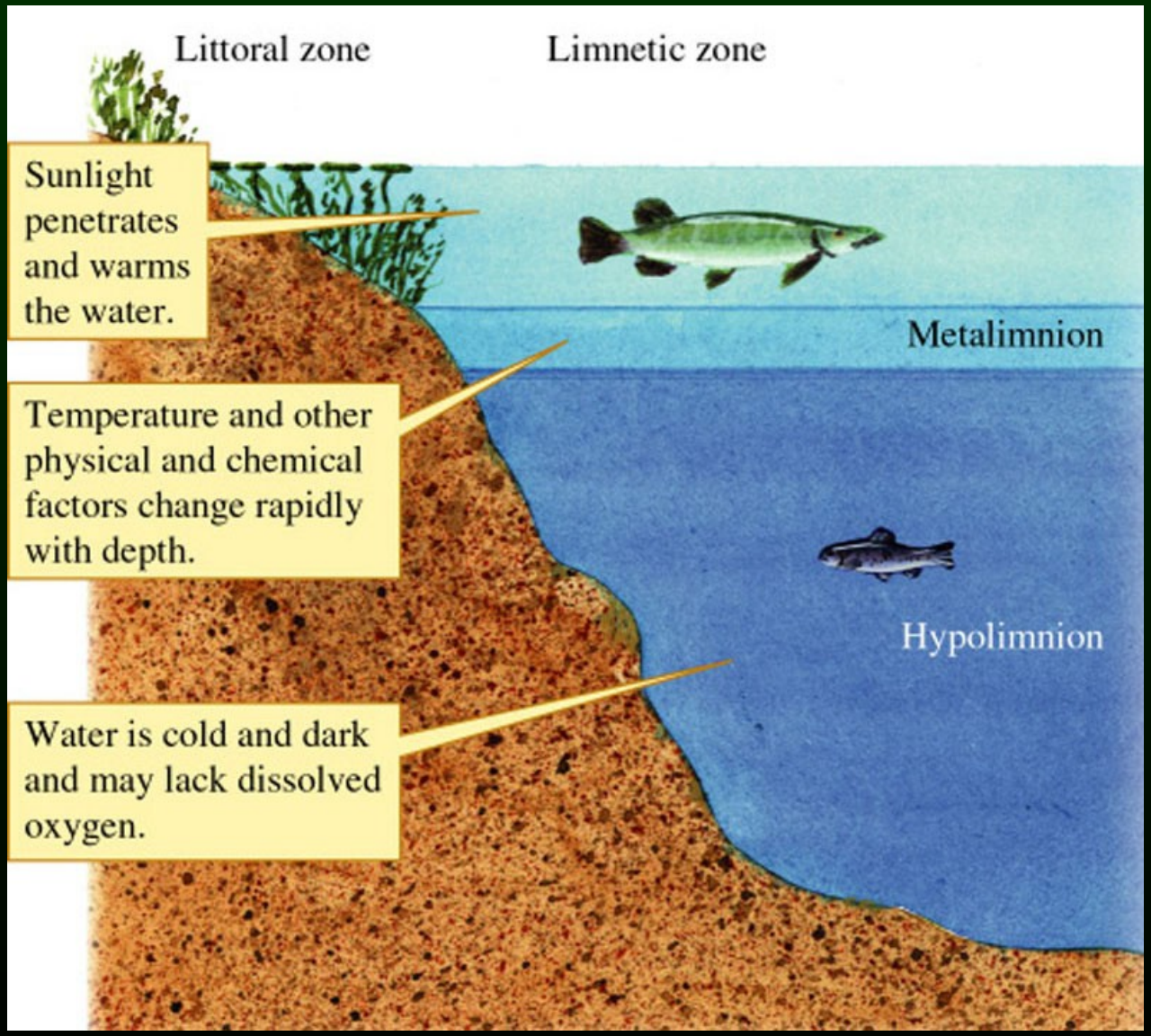


Lakes - Structure

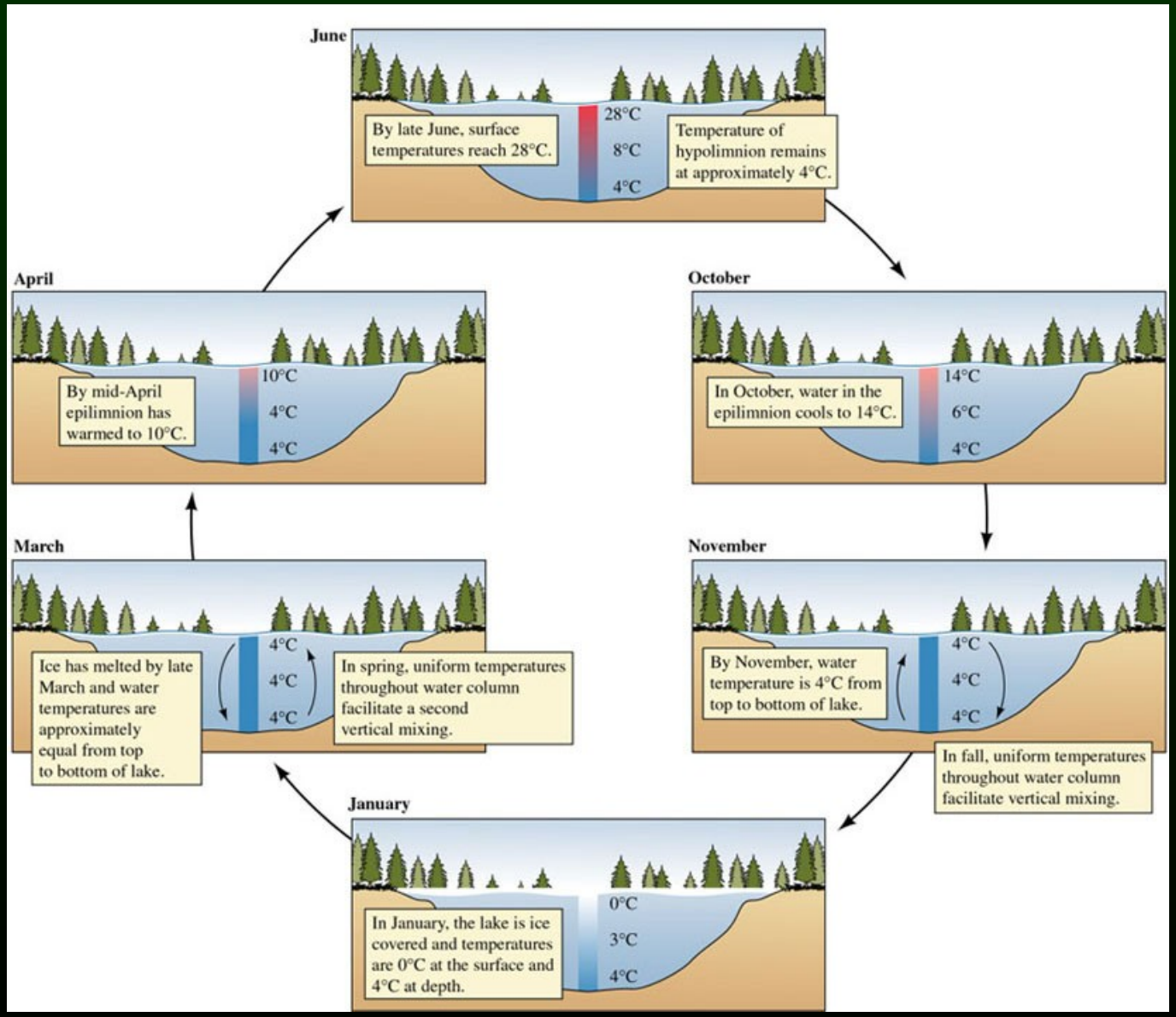
- Structure
  - Littoral zone (lake shore) : Shallows
  - Limnetic zone: Open lake
    - Epilimnion: Warm surface layers.
    - Metalimnion: Temperature changes with depth (the lake thermocline).
    - Hypolimnion: Cold dark waters.



Lake Structure



Seasonal Temperature Changes



Lakes - Chemical Conditions

- Salinity – HUGE RANGE!!!
  - Alpine lakes – tiny fraction of ocean salinity
  - Great Salt Lake – Over 6 times the salinity of the ocean!!!
- Oxygen
  - Oligotrophic: Low biological production, although often well oxygenated.
  - Eutrophic: High biological production, but may be depleted of oxygen.

Lakes - Human Influences

- Human populations have had profound, usually negative effect.
  - Municipal and agricultural run-off.
  - Exotic species – Zebra & Quagga Mussels

http://www.youtube.com/watch?v=9_J9K-ItPis