Nutrient Cycling

- Soil type: oxisols
  - Deeply weathered, severely leached
  - Rapid bacterial decay prevents accumulation of humus
- Approx. 90% of nutrients are held by standing vegetation
- If you cut down the forest for farming or ranching …

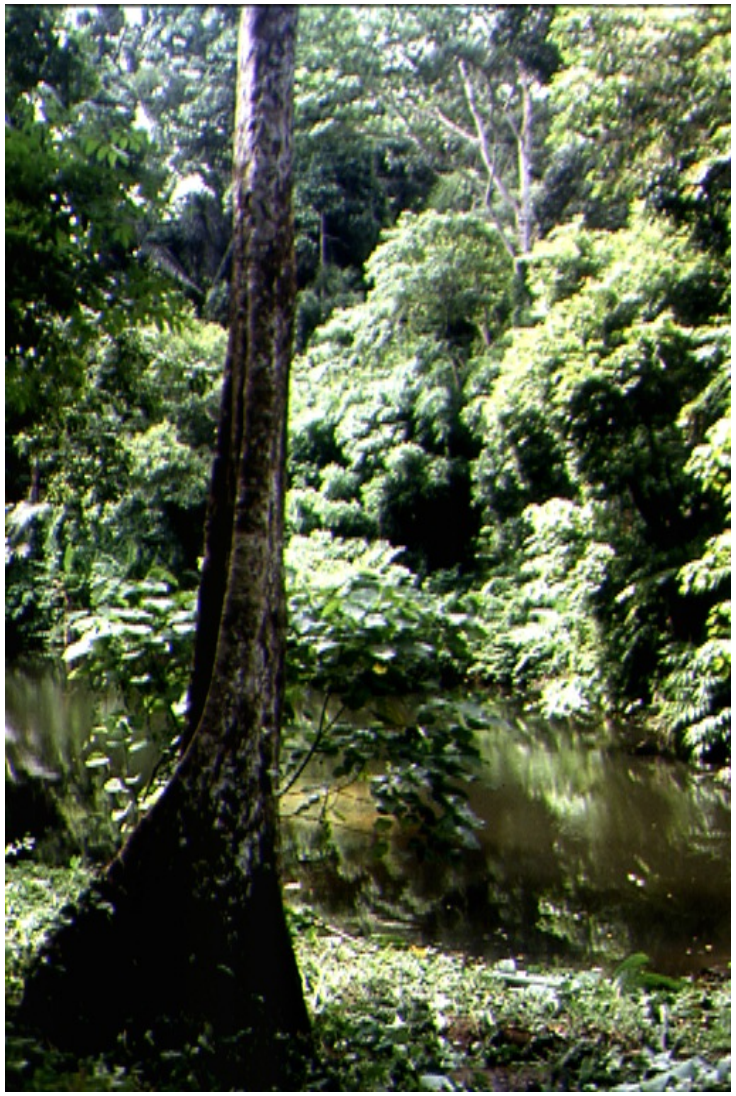
Diversity

- Tropical rain forests contain approximately half of all living species
- Tree diversity alone can be 150-500 species (> 1 cm dbh) per hectare
- Diversity likely contributes to high productivity in tropics
  - NPP of 1000-3500 g/m2/yr
  - Accounts for over 30% of global terrestrial NPP
- Fragmentation can be particularly detrimental

TRF - Plant Forms

- Tall trees
  - Buttresses and Thin bark
  - Large leaves with drip tips
  - Flowers pollinated by animal vector (insect, bird, bat)
  - Cauliflory
  - Large fleshy fruits
- Epiphytes—bromeliads and orchids
- Lianas—woody vines
- Climbers—herbaceous like philodendron
- Stranglers—often figs

Tropical Lianas, vines and epiphytes



Small and large buttress root systems from Australia and Thailand. Note slender trunk above buttress.

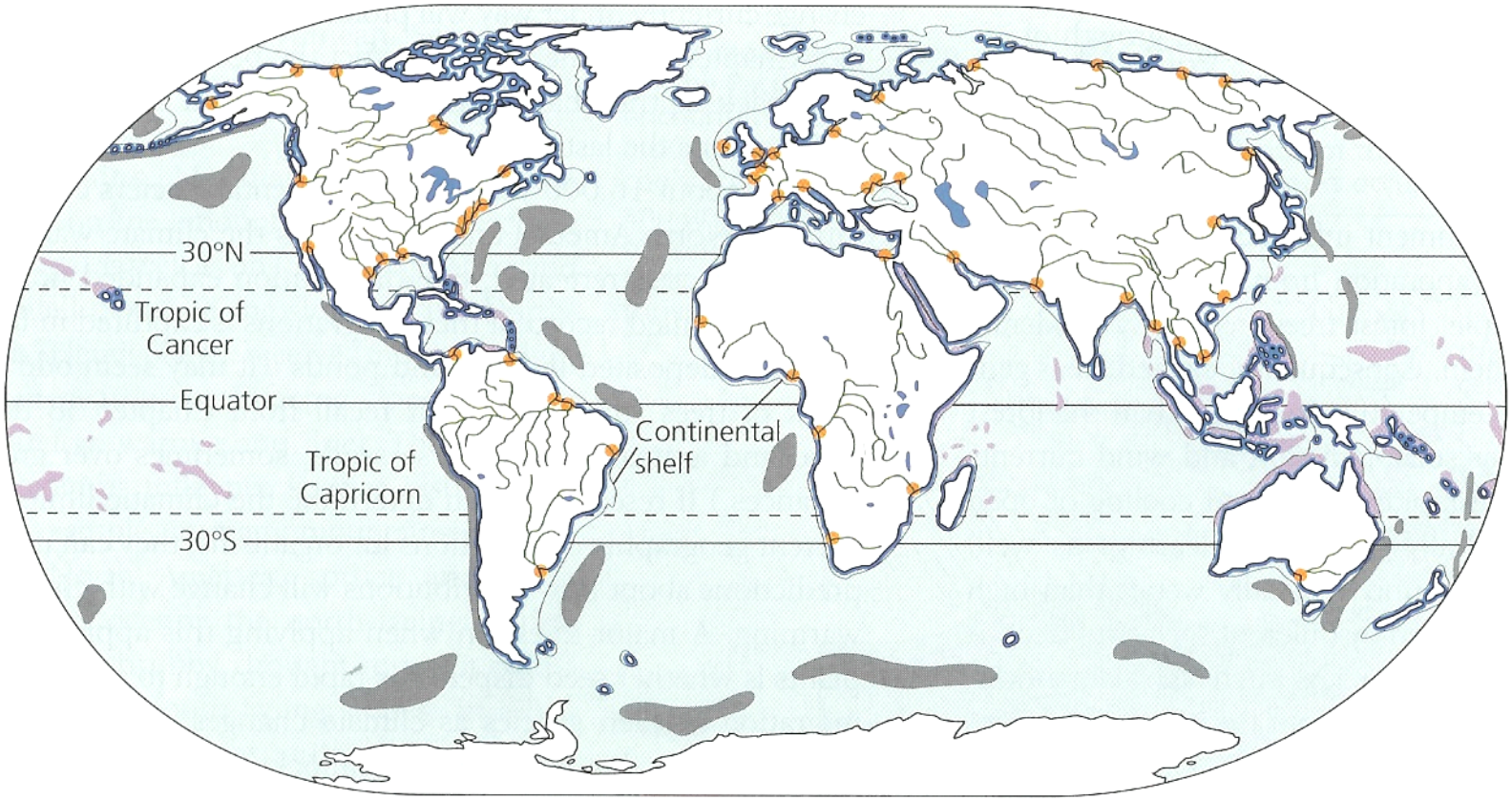
TRF-Animals

- Highly diverse
- Adapted to arboreal life
- Bright colors and sharp patterns
- Diets heavy on fruits

Now, for **three-fourths** of the earth's surface, the aquatic habitats

- When we look at these different biomes, as is true in the terrestrial environment, there is often gradation among the biomes
- There are levels of division here – what are the major divisions? What is the intermediate?
- Within these major divisions, we can also look at a variety of habitats

Distribution of Habitats



Key

- Lakes
- Coral reefs
- Rivers
- Oceanic pelagic zone
- Estuaries
- Intertidal zone
- Abyssal zone (below oceanic pelagic zone)

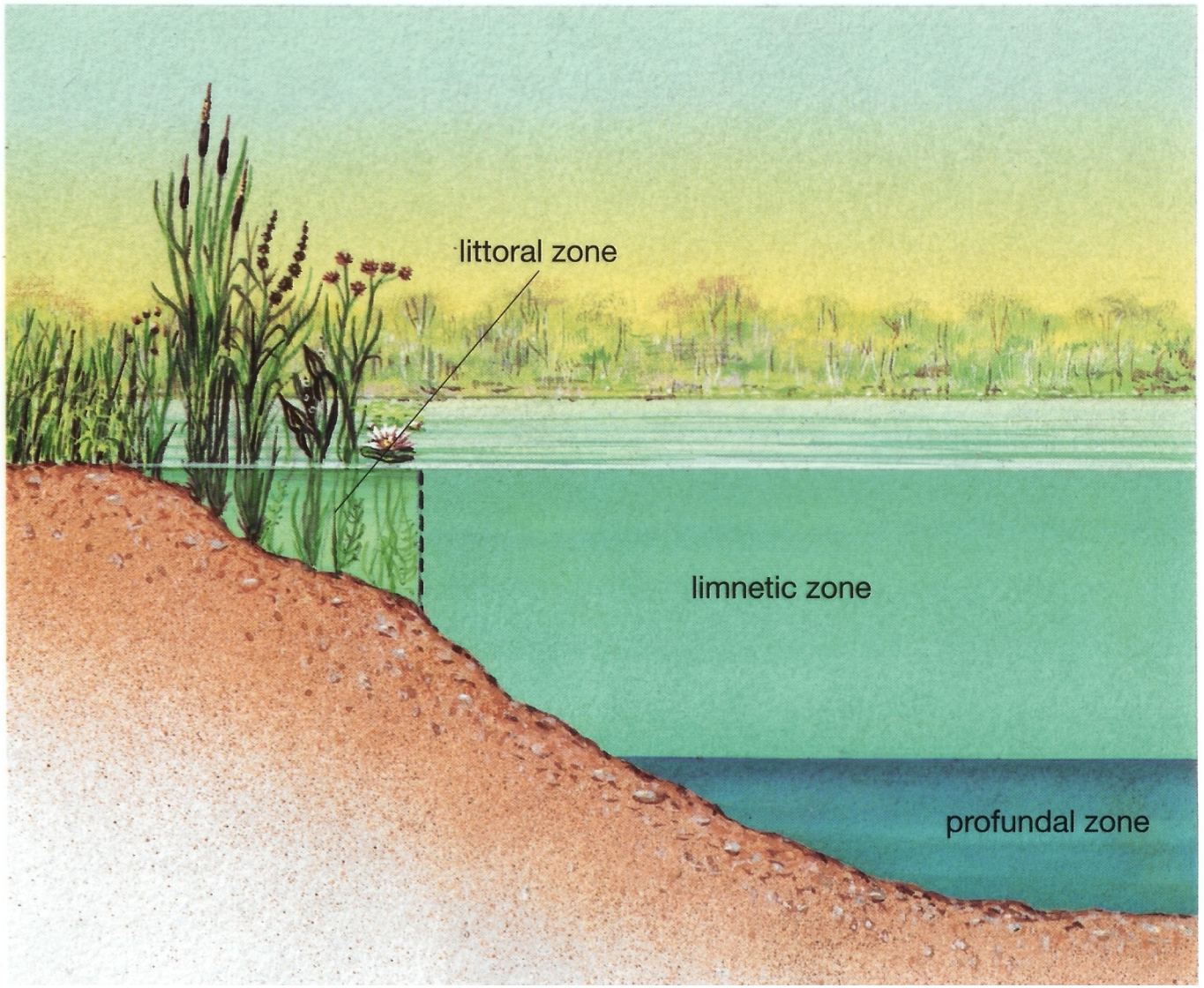
Lentic Freshwater

- Found on every continent with the exception of Antarctica
- Lentic systems include still water habitats; lakes, ponds and wetlands
- Change is unidirectional and quite predictable in terms of the process
- Variable in form, but changes in biota, productivity and chemical characteristics are predictable as the structure changes

Variation in this biome

- There are some well-defined zones in this biome, each with specific characteristics
- Remember now we have an added consideration of pressure that impacts the organisms and this three-dimensional space (that is habitable for a variety of organisms)
- Take a look at the zones in a lentic habitat

Lifezones in Lentic systems



Formation of Lentic Systems

Alternatively…

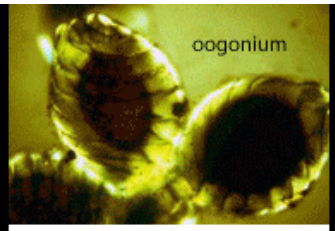
Volcanism is another mechanism,

- But regardless of how the lentic system is formed, once formed it starts to shrink
- The fate of still water systems is to be gradually filled in due to erosional processes
- Thus the change from a deep, well oxygenated, oligotrophic body of water to an increasingly shallow system with high nutrients and productivity (eutrophic)

Common Aquatic Plants

- We find both algae and vascular plants in most lentic systems. The near lack of water movement allows for weakly attached species and even floating forms to thrive
- Associated with the shore-line, we also see a characteristic group of plants that cannot survive far from plentiful water

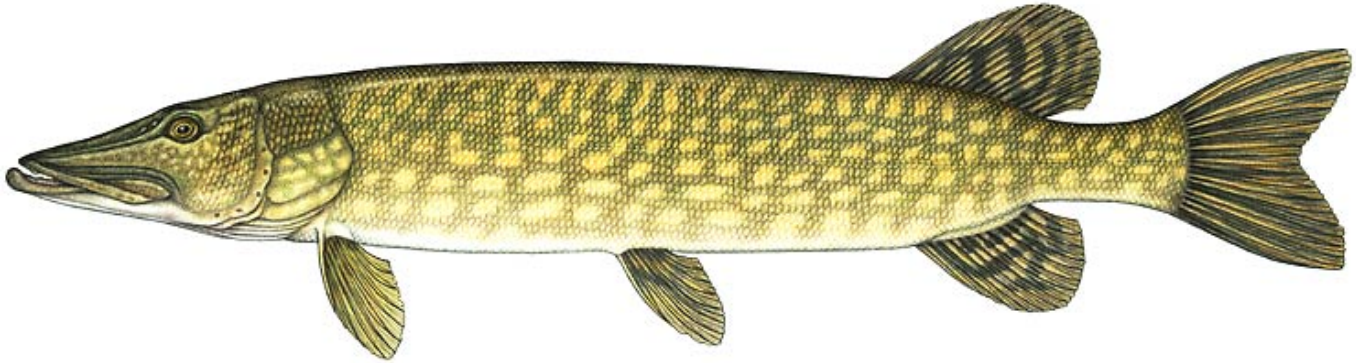
A few of the plant species

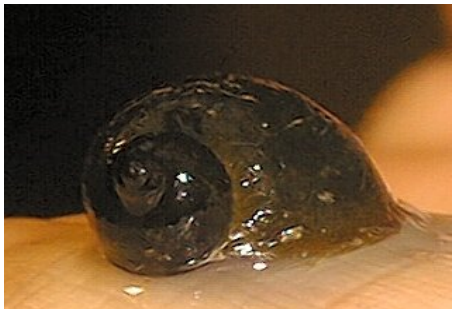


Nutrient distribution

- Aquatic habitats have an added variable when we consider the availability of nutrients for the primary producers
- As organisms expire, the nutrients become deposited on the bottom – often out of reach for the photosynthetic organisms (i.e., below compensation depth)
- This material must be cycled, and this occurs at the spring and fall turnovers

Freshwater Animals





Status of Lentic Systems

- From the deepest lake to the shallowest marsh, the influence of humans is exerted
- Recreation and proximity of dwellings has severely impacted many of these habitats
- Destruction, overexploitation, fragmentation, and pollution have all caused irreparable damage to many habitats

Now the Lotic Systems

- Moving water biomes, including streams and rivers. Whereas the fate of lentic systems is to shrink, lotic systems grow, again due to erosional changes over time
- Changes are associated with flow rates, substrate, gasses and temperature
- What about heterogeneity in this habitat?

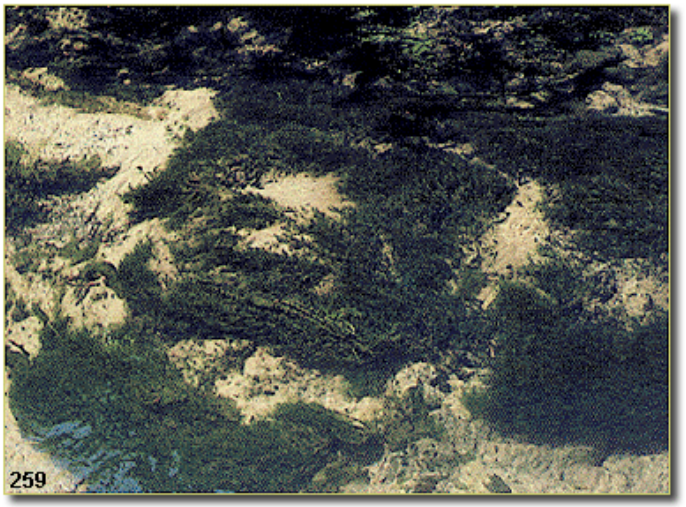
Heterogeneity in this habitat

- Depth, not much of an issue when we consider the adaptations of organisms to this habitat
- But, the variation in flow rates is an important factor in the distribution of plants and animals in the lotic biome
- Effects that flow rate has on the organisms

Water flow

- Gasses, specifically dissolved oxygen concentrations are much higher in fast moving systems compared to systems with slow rates
- Anchoring of the organisms becomes a real issue in fast currents
- Temperature is also directly related to flow rates as is the substrate composition
- What do these mean for the organisms?

Some of the organisms



Status of Lotic systems

- Pressures faced by the lentic habitats are also faced by the lotic systems
- The desire for recreational activities, over-fishing and pollution are devastating to many of these habitats
- Two other very important activities directly alter the characteristics of these habitats

Where is the power?

- Dams as a source of hydroelectric power represent a complete alteration of the natural characteristics of the system
- The other major feature here might be called pollution, but not chemical residues, sedimentation based upon human activities


COE, Columbia River looking east
OREGON
WASHINGTON
Columbia River
Table Mountain Landslide
Bonneville Dam
Bradford Island
Hamilton Island
U.S. Army Corps of Engineers

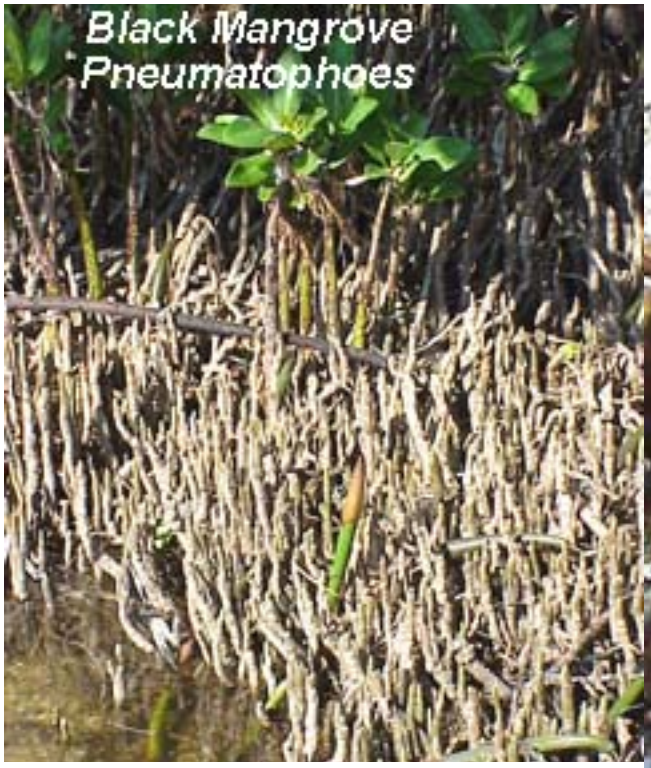
Transitional Aquatic Habitats

- Estuaries
  - Areas of high nutrient availability,
  - Relatively high productivity, and
  - Immense physiological stresses
- Area of mixing of the fresh and salt waters. But what other than salinity is changing in this habitat?
- What does this mean for the organisms?

Unique habitats

- Consider these habitats with regard to the **amount of nutrients and sediments** that are being deposited in this habitat – the nutrient availability is very high (source?) and the substrate is sand/mud/silt (think about this in terms of the flow velocity not only in large systems, but as it meets the ocean)
- So, **productivity is**…?
- What about the **species diversity** in this specific habitat? Would you expect the diversity to be high or low?

Common Plants of the estuary



Now the beasts

Status?

- Next to the ocean, in a protected bay, a great place to build your home and dock for your boat…
- Estuaries and bays also tend to draw commercial activities for products extracted from either the ocean or the estuary itself – where do the wastes go?

Marine Habitats

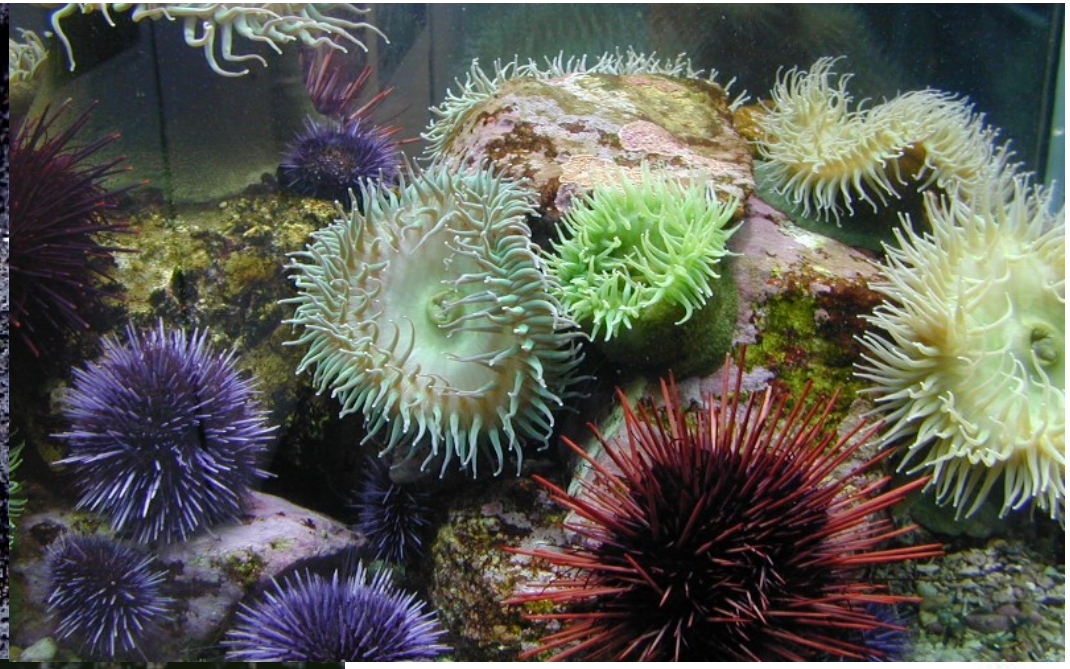
- Within the marine environment, there are a variety of ways to identify different biomes, but we will adopt the following
  - Intertidal
  - Near-shore shelf
  - Photic open ocean (pelagic)
  - Aphotic open ocean
  - Deep benthic/abyssal
- We are doing it again – lumping!

Definition of the Intertidal Biome

- How is this region defined? Salinity is stable, but there are two major pressures in this region – **what are they?**
- For comparison, look at the sandy beach (mudflats) vs. the rocky intertidal. How are they similar? How are they different? What types of communities do you find in the different habitats?
- What about levels of diversity?

What are the dominant plants?

Now, how about the animals?

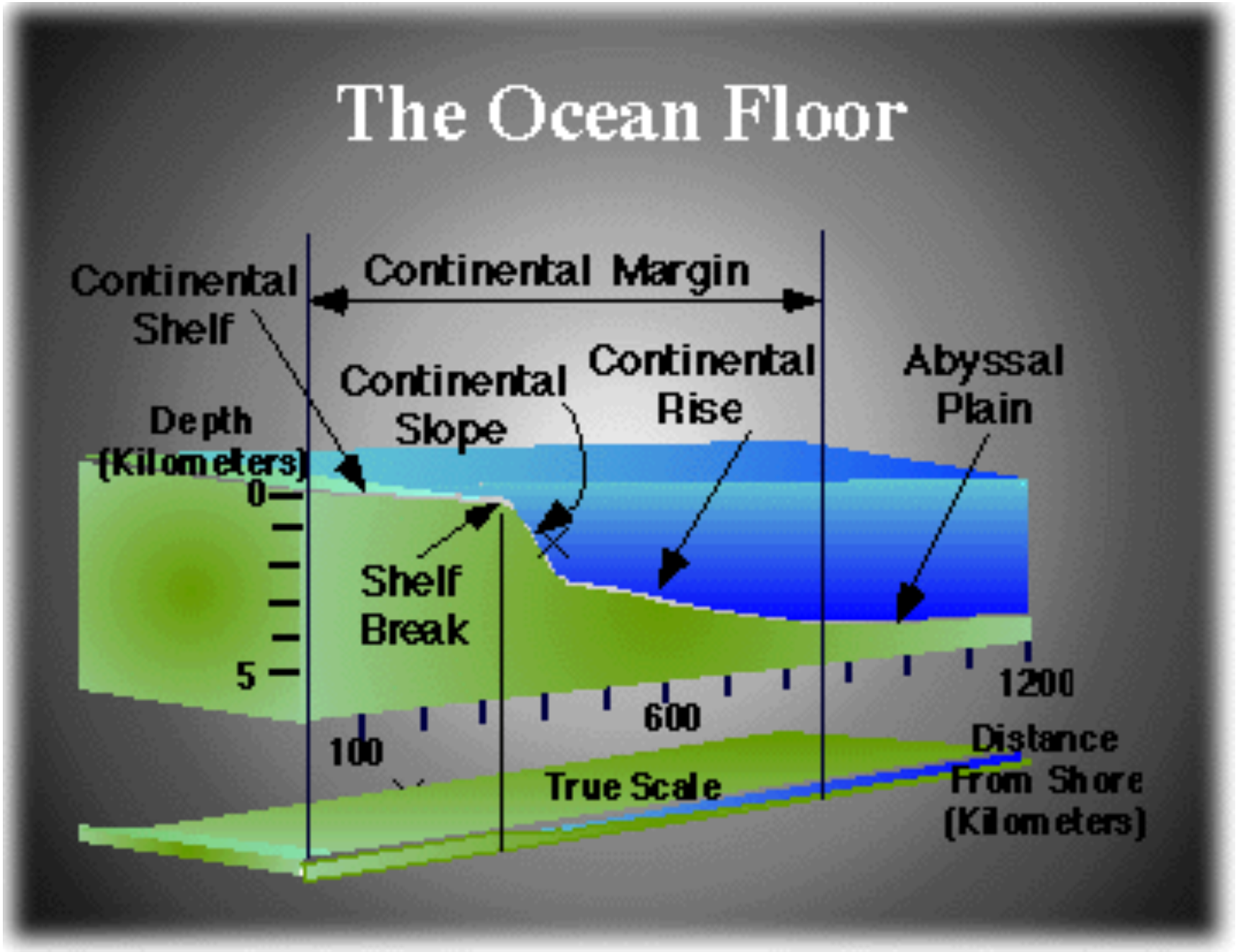


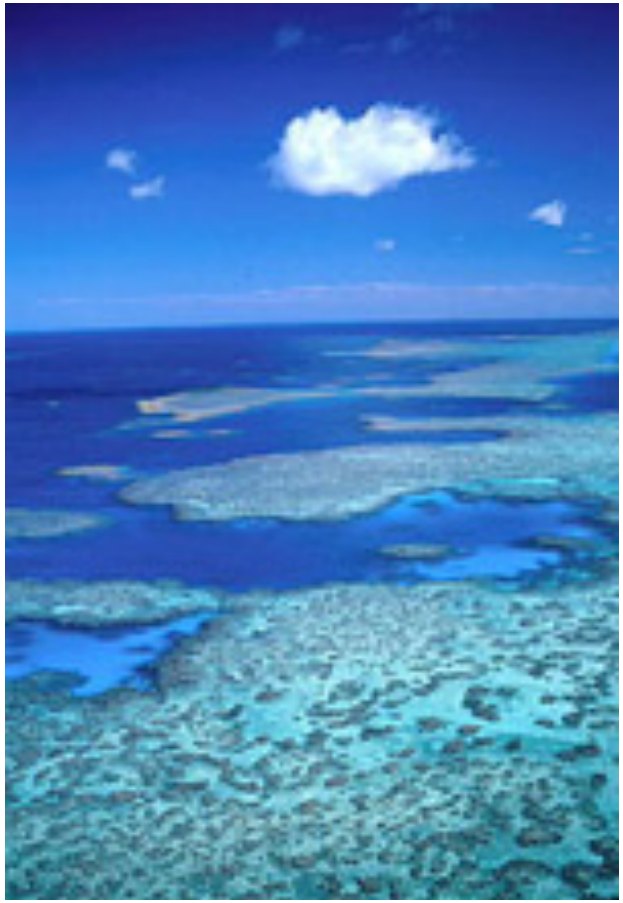
Status of the Intertidal

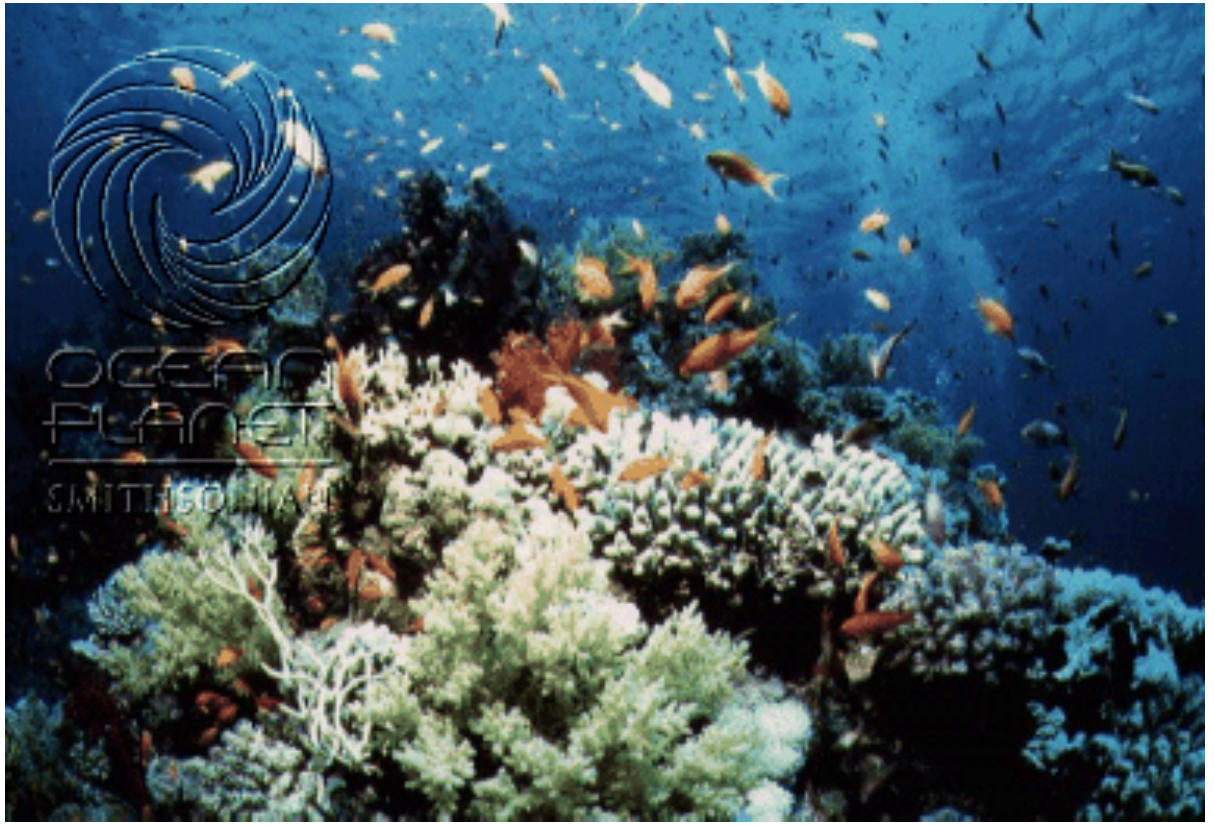
- Impacts range from physical destruction to the effects of pollutants directly dumped into the water and as runoff from the adjacent land
- Near-shore habitats are under constant pressure, not only due to the natural factors and now humans

Near-shore subtidal

- Definition is difficult due to variability
- These range from soft-bottom subtidal areas to the coral reef communities – that is, near depauperate to extraordinarily diverse communities
- Margin is defined by the edge of the continental shelf (depths of 200 to 500 m)


The Ocean Floor
Continental Shelf
Continental Margin
Continental Slope
Continental Rise
Abyssal Plain
Depth (Kilometers)
0
5
Shelf Break
100
600
1200
True Scale
Distance From Shore (Kilometers)

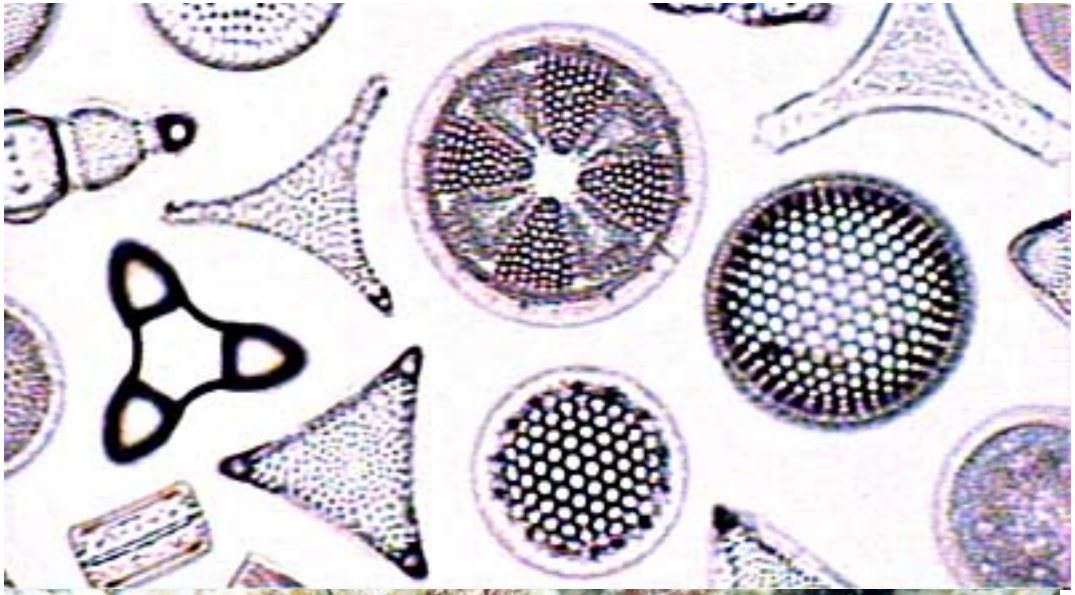



OCEAN
PLANET

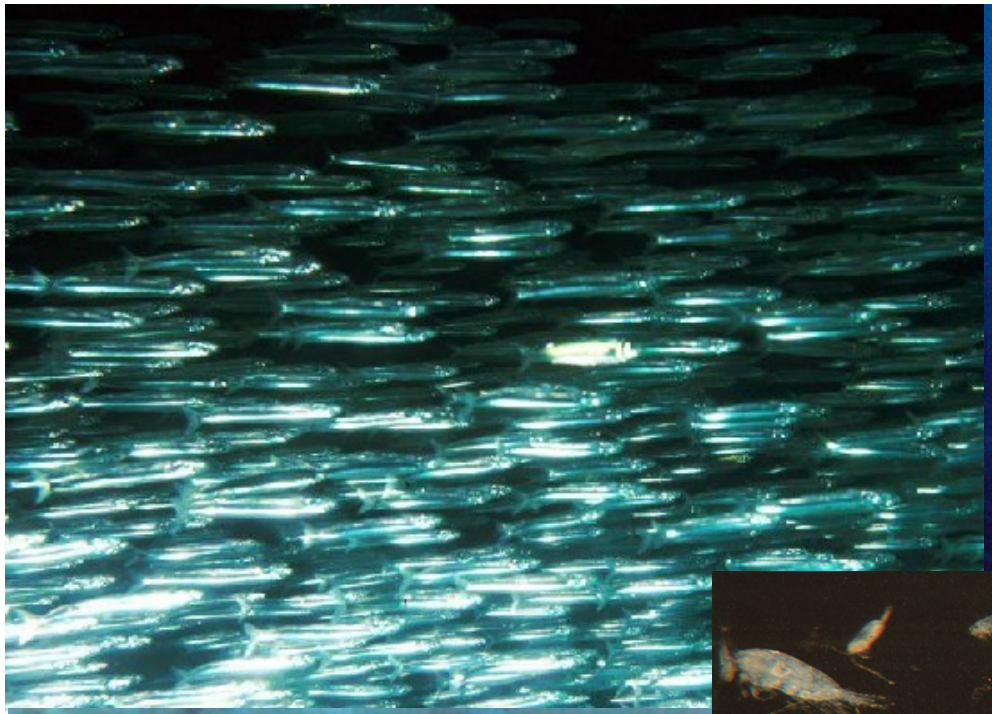
Productivity

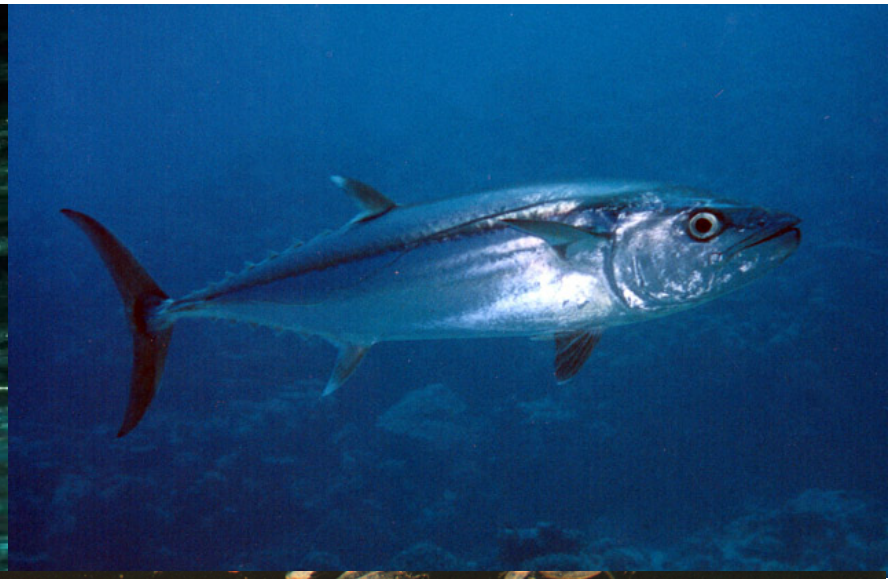
- Productivity is as variable as the substrate type, but what is important is that this area is almost always in the photic zone – that is, **above the compensation depth**
- General source of primary productivity? What about in the deeper areas?

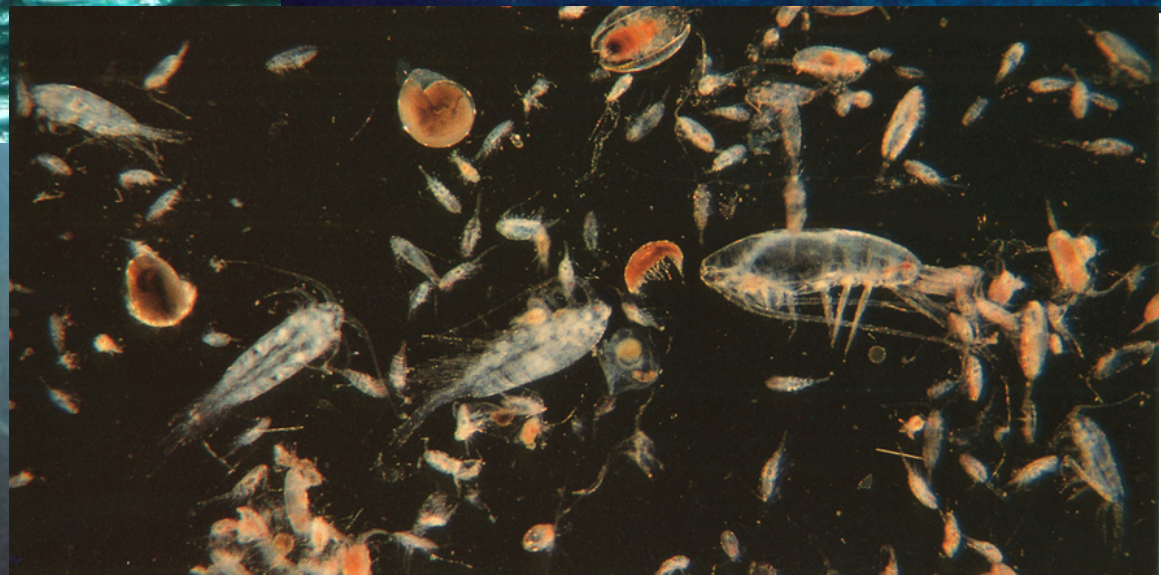
Producers of the near-shore



Some of the Animals

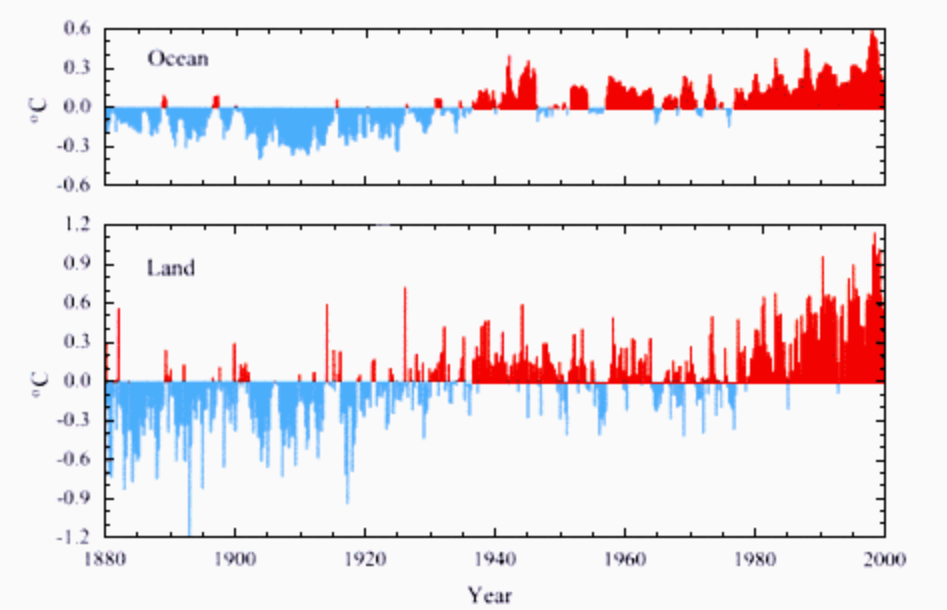


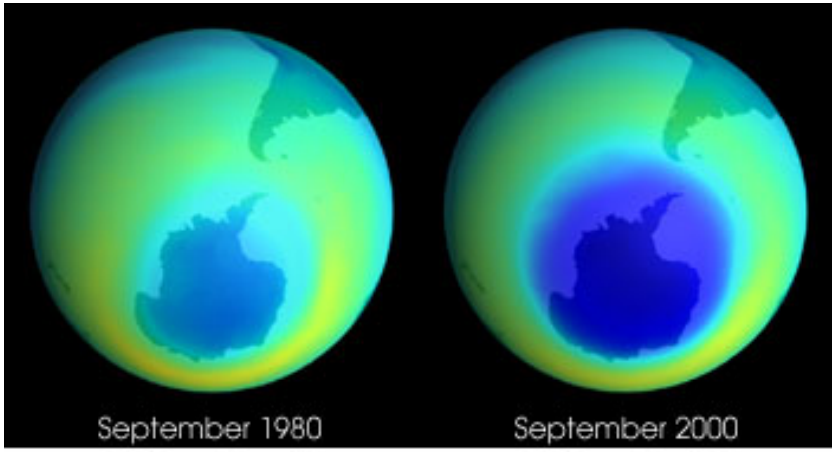




Status of the Near-Shore habitats

- What sorts of impacts do we see on these habitats?
- What about on a global scale? You could consider this from both a physical standpoint and from direct effects on the organisms

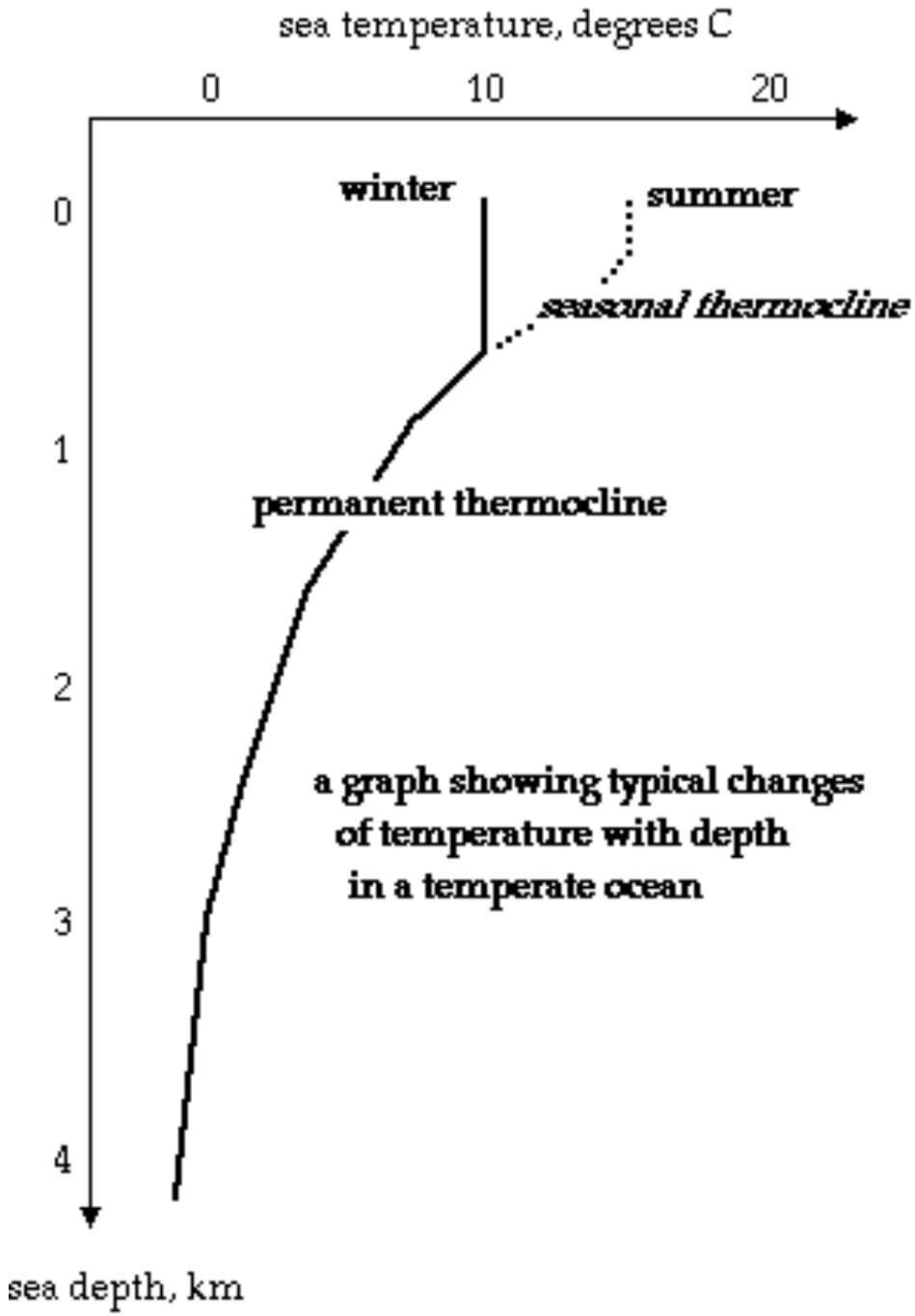

Ocean
Land
°C
0.6
0.3
0.0
-0.3
-0.6
1.2
0.9
0.6
0.3
0.0
-0.3
-0.6
-0.9
-1.2
1880
1900
1920
1940
1960
1980
2000
Year


September 1980
September 2000


Total Ozone (Dobson Units)
100
200
300
400
500

Photic Open Ocean

- Pelagic habitats that are not over the continental shelf zones and above the compensation depth (highly variable depending upon the clarity of the water but generally this is between 100 and 200 m)
- Conditions are generally homogeneous in this biome, with the exception of temperature and pressure!


sea temperature, degrees C
0
10
20
0
1
2
3
4
winter
summer
seasonal thermocline
permanent thermocline
a graph showing typical changes
of temperature with depth
in a temperate ocean
sea depth, km

The wide open spaces

- Temperature impacts the distribution of these forms, but in terms of the physical stresses – life is good, as long as you are the big fish
- But what if you are not – how do avoid being the next item on the menu? That is, **no heterogeneity in the environment**
- Pressures based upon biotic pressures here are intense and far-reaching

Producers?

- Phytoplankton are the primary producers, planktivores as the primary consumers, etc.
- The diatoms, dinoflagellates and other unicellular algae are the phytoplanktonic forms at the base of the food web, and many of the common zooplankton are similar to members of other communities

Many of the abundant forms are…

- Midwater (mesopelagic) species that exhibit daily vertical migrations using the cover of darkness to avoid, or at least minimize, predation
- The community forms the deep-scattering layer, a layer of organisms that creates the appearance of a false bottom to the ocean and moves based primarily on light levels

Other pelagic forms

Status of Pelagic Biomes

- The world oceans are faced with basically all of the same issues
  - Overexploitation of resources
  - Chemical pollution
  - Global trends in temperature regimes
  - Effects of destruction of ozone
- These pressures are real and important for our consideration on a personal and professional level

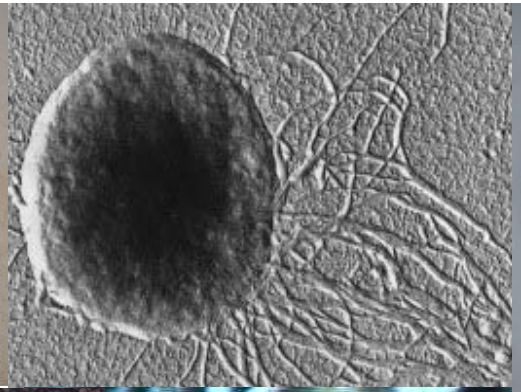
The last biomes we will consider

- The deep ocean (aphotic zone) and benthic regions
- The mesopelagic zone is generally defined as the region between 500 – 2000 m
- Light never penetrates these regions – other than bioluminescence from the inhabitants
- Temperature and pressure again top the list of selective pressures (physically)

What are the other issues here?

- Dinner?
- What is the source of nutrients in this habitat? What is the productivity here?
- What about on the bottom? What does the diversity of this habitat tell us about the amount of available energy?
- What is an alternative source of nutrients for some of the lucky few?

Some of the beasts



Fascination with the deep

- The deep ocean holds a special place with many of us mainly due to the unknown nature of many of the organisms associated with these areas
- But the reality is that we know very little about the physical and ecological features too, and we are only beginning to see the real diversity and abundance of life in the deep ocean habitats
- The deep ocean may also hold the key to our understanding of the origin and evolution of life on earth