ECOLOGY

1. ECOSYSTEMS

ecology - study of interactions between
organisms & their environment
- esp. distribution & abundance

biosphere - 8-10 km supporting life
- ocean covers 70% earth's surface

ecosystem - specific environment
- both biotic & abiotic components

population - includes 1 species only

community - includes all different species

habitat - organism's location

niche - organism's ecological role (food)

2. MARINE FACTORS

light - decreases rapidly with depth
- red light limited close to surface
- blue light penetrates deeper

temperature - effects metabolism
- decreases with depth & latitude
- fairly constant within local environment

gravity - less important than on land
- tissue same density as seawater
- buoyancy counteracts weight

pressure - from weight of the water above
- increases with depth

viscosity - fluid resistance to flow
- decreases with temperature, increases with salinity

currents & tides - lunar cycles

3. SEAWATER CHEMISTRY

salinity - averages 3.47% = 34.7‰

- seawater saltier than most tissues
- so tissue gains salt + loses water

O_2 - less than atmosphere, decreases with depth

CO_2 - more than atmosphere, increases with depth

pH 7.8 - slightly basic (not acidic)
- deep water more acidic (pH 7.5 more H^+, less photosynthesis, more CO_2 increases H_2CO_3)

other nutrients - nitrate NO_3^- & phosphate PO_4^{-3}
- calcium carbonate $CaCO_3$ & silicate SiO_2 (shells)

4. MARINE ZONATION

light zones
- photic (upper 100-200m)
- aphotic (no light below)

temperature zones
- eurythermal (temperature uniform from mixing, also seasonal changes)
- thermocline (temperature drops sharply)
- disthermal (perpetual cold, dark)

ecological zones
- pelagic (in open water)
  - neritic (nearshore, continental shelf)
  - oceanic (beyond continental shelf)
    - epipelagic (surface, photic)
    - mesopelagic (mid-water)
    - bathypelagic (above floor)
    - abyssopelagic (in trench)
- benthic (on ocean floor)
  - littoral (between tides)
  - sublittoral (on continental shelf)
  - bathyal (on continental slope)
  - abyssal (on deep ocean floor)
  - hadal (on walls of trenches)

5. PRIMARY PRODUCTIVITY

energy - all originally from sun

primary (I°) productivity
- amount food made by producers

- photosynthesis (plants & cyanobacteria convert light)
- chemosynthesis (chemical energy, high-temp thermobacteria convert hydrogen sulfide H_2S)

ocean productivity
90-98% unicellular algae
2-10% seaweeds
< 10% sea grass & mangroves
< 1% chemosynthetic bacteria

6. ENERGY FLOW

trophic levels
• producers (I° productivity)
• consumers (II° productivity)
  - herbivores (eat plants)
  - I° carnivores (eat herbivores)
  - II° carnivores (eat I° carnivores)
• decomposers (eat dead)

food chain - single path of energy
- usually 4 levels (minimum 2, ocean >4)

food web - combine all food chains
- more stable if more diverse

food pyramid - quantify energy in food chain
- only transfer 10% between levels

7. SYMBIOSES

symbiosis - relation between 2 species
0 if no effect, + if benefited, – if harmed

neutralism [0 0] - no effect on either species

competition [– –] - both species harmed
- leads to evolution of different species

predation [+ –] - culls weak/old, increases species diversity
- parasitism - smaller than host, kill gradually, nonfatal

mutualism [+ +] - both species benefited
- anemone fish & cleaner fish
- zooxanthellae in anemone/coral

commensalism [+ 0] - lives in host without harming it

8. POPULATION GROWTH

opportunist species - J-curve
- most plants, invertebrates, fishes
- small organisms in unstable environment
- low survival rate (most get eaten)
- high reproductive rate needed to compensate

equilibrium species - S-curve, birds & mammals
- larger organisms in stable environment
- decent survival (parental care)
- so high repro rate not needed

9. EL NIÑO CURRENT

ENSO - every 3-8 years, last 1-2 years
- El Niño ('*Christ Child*') current
- Southern Oscillation wind
- tropical Pacific current flows east (trade winds normally flows from east to west)

current - warm & nutrient-poor water, esp. S. America
- disrupts upwelling of nutrients from ocean floor
- evaporation intensifies global weather (drought, storms, floods)

Calif - invasion by tropical species
- native organisms relocate deeper
- food reduced, so fewer predators
- decrease species diversity & fishing

10. LA NIÑA CURRENT

La Niña - often follows El Niño year
- also begin in winter, last 1-2 years
- opposite but not simply reversal
- less understood & harder to predict

current - tropical Pacific colder than usual
- resume normal flow from east to west

weather - draws thunderstorms to west
- jet stream weakened & variable

US - northwest colder
- southeast warmer & maybe drier
- Atlantic/Gulf coasts more hurricanes