

- 1 Introduction to Oceanography
- 2 1. Describe the two bases for delineation of pelagic zones.
- 3 2. Identify the zones and their boundaries of the pelagic realm.
- 4 . Identify location of DSL and explain why it changes with a diurnal pattern.
- 5 4. Distinguish between thermoclines and isoclines.
- 6 5. Identify the benthic zones and their boundaries.
- 7 6. Locate the 4 major divisions of the world ocean.
- 8 7. Distinguish between ocean and seas. List the 2 types of seas and give some examples of each type.
- 9 8. Distinguish between oceanic crust and continental crust.
- 10 9. Explain the concept of isostasy.
- 11 10. Describe Pangaea, Panthalassa, Laurasia, Gondwanaland, and the Tethys Sea.
- 12 11. Describe how the concept of Pangaea can be verified.
- 13 12. Define plate techtonics.
 - Plate techtonics: deformation of the earth's surface of lithospheric plates
 - by the forces generated by the heat flow of the Earth's interior.
- 14 13. Explain the 3 processes of plate techtonics.
- 15 14. Describe the basic geomorphology of the ocean floor.
 - Continental shelf, continental slope, abyssal plains, submarine ridges, seamounts, and trenches
- 16 15. Identify the range of temperatures that most organisms are able to tolerate.

Give the relationship between temperature and metabolic processes.

 - 0-40oC; metabolic processes > x2 for each 10oC rise in temperature in poikilotherms.

- 17 16. Explain the difference between poikilothermic organisms and homeothermic organisms.
- 18 17. Identify the biogeographical zones of the ocean.
- 19 18. Explain the relationship between thermoclines and pycnoclines.
- 20 19. Identify 2 types of motion produced by winds.
- Waves
 - currents
- 21 20. Describe waves.
- Wave height
 - Nodal line
 - Amplitude
 - Wavelength
 - Wave period
- 22 21. Explain how waves are formed.
- Wind catches water, creating an edge due to friction, pushes the edge of the water to form a wave
 - Once generated, all waves move outward and away from center of origin
 - Water molecules transcribe a circle
 - Move upwards & to one side as crest approaches; move to other side & down to original position as crest passes by
 - Passage of waves generates movement about $\frac{1}{2}$ wavelength down in the water
- 23 **Wave movement**
- Wave form and energy are transported horizontally, water is stationary
 - When waves enter shallow water and hit frictional resistance of bottom, slow forward motion and wavelength decreases
 - As a result, there is increase in height and wave gets steeper
 - At point where water depth is 1.3 times height of wave it will break, energy is released on shore
 - In sea waves are usually less than 2 m & have period of 12s
 - Lg wind generate wave of 34m 14.8s
 - Steepness reaches 1/7 open ocean breakers form whitecaps
- 24 22. Explain the 3 factors which determine the amount of energy gained by waves.
- Fetch: DISTANCE over which wind blows
 - How long wind has blown continuously
 - Wind intensity
- 25 23. Describe wave types and the forces that affect them.

- Capillary waves, gravity, swells, and storm surge/tsunamis waves
- 26 24. Distinguish between free and forced waves.
- Free waves: moving w momentum and energy imparted to it in sea
 - Forced waves: move w force-wind periodicity coincides w period of wave – wind is pushing the wave
- 27 25. Explain wave interference patterns.
- Superimposition of waves
 - Constructive interference: additive waves trains w same wavelength; come together crest to crest and trough to trough
 - Destructive-crests coincide w troughs
 - Mixed-waves of differing heights w both destructive and constructive wave patterns
- 28 26. Explain why longshore currents and rip currents are opposite phenomenon.
- Longshore: waves strike shore at an angle, set up a longshore movement of water velocity
 - Rip currents/tides: backwash of water from waves that broke on shore returning to the ocean
 - Less than 25 m wide and can attain velocities of 4-5 mph
- 29 27. Distinguish between offshore, nearshore, and shore (foreshore, backshore).
- 30 28. Explain how tides occur and distinguish between spring, neap, semidiurnal, mixed semidiurnal, and diurnal tides.
- Spring: moon and sun aligned
 - Neap: moon and sun opposite
 - Semidiurnal: two tidal cycles a day
 - Mixed semidiurnal: two tidal cycles a day with disparate heights
 - Diurnal tides: one tidal cycle a day
- 31 29. Explain the concepts of upwelling and downwelling. Account for blue whale migration patterns.
- 32 30 Describe and distinguish between tsunamis, typhoons, and hurricanes. Describe internal waves and compare internal waves to storm waves. Describe the effect of storm waves on the neritic zone.
- 33 31. Identify and describe the Gulf Stream. Explain how the Gulf Stream differs

from the Labrador current. Explain how eddies occur and the effect they

have on planktonic communities. Identify the analogous current in Pacific.

34 32. Explain how Perfect Storm occurred and why its effects were devastating to the fishing

industry

- 28 October 1991 Halloween Storm or Hurricane Grace
- Hurricane Grace forming off Bermuda on 27th Oct turned NE
- Great lakes storm system moving east
- Canadian cold front moving south; formed large Nor'easter

35

36

37 Currents in Atlantic Ocean

38 Grand Banks

- 12 years after Columbus, fishing Grand Banks for cod
- Salted on boat or on islands
- Each boat hundreds of thousands of fish
- 1623 Dorchester Company sent ships to fish
- first year bottom dropped out when violent gales caused ships to crash/ sink
- Some fisherman remained as settlers: Gloucester, Massachusetts
- 4% fisherman from Gloucester drown each year
- Since 1650, 10,000 fisherman have died

39 Grand Banks Geography

- 1,200 miles east Gloucester and 400 miles from Newfoundland
- Prevailing winds are out of northwest
- Canada claims 200 miles out on shelf
- Low pressures from Great Lakes pushed by jet stream over Grand Banks
- On storm track
- In fall, warm water eddies from Gulf Stream on tail of Banks

40 Georges Bank

- 180 miles east of Cape Cod
- Tide runs off fast
- Currents run in vortexes
- shallow
- Huge primary productivity leading to great concentrations of marine life

- 41
- 42 Hurricane Betsy 1956
- 43 Hurricanes Edith and Flora, 1964
- 44 Hurricane Cleo 1964
- 45 Hurricane David 1979
- 46 Hurricane Emily 1987
- 47 Hurricane Hugo 1989
- 48 Humberto, Iris, Jerry 1995
- 49 Hurricane Hortense 1996
- 50 Hurricane Edouard 1996
- 51 Hurricane Fran 1996
- 52 Hurricane Bonnie 1998
- 53 Hurricane Bonnie 1998
- 54 Hurricane Floyd 1999
- 55 Hurricane Floyd 1999
- 56 Hurricane Gert 1999
- 57 Hurricane Michael Oct 2000
- 58 Hurricane Erin 2001
- 59 Hurricane Gustav 2002
- 60 Hurricane Isabel 2003
- 61 Hurricane Isabel 2003
- 62 Jet Stream
- 63 US at Night
- 64 Europe at Night

65 **Asia at Night**

66 **Fishing**

- Cod/halibut especially at Georges Bank
- Swordfish: spawn in Caribbean, feed north, work depths (3000') to shallows for squid (found in stomachs), hake, cod, butterfish, bluefish, mackerel, menhaden, and bonito
- At night follow prey to surface and feed at night
- Cold protein rich waters

67 **Commercial Fishing**

- One boat may use \$20K gear in ocean at night
- Fish 30-40 miles of line
- Use light sticks and baited hooks
- mid 1980s: 7000 boats, 50 million hooks
- Late 1980s: 100 million hooks
- Swordfish fishery collapsed in late 1980s
- 1976 Magnuson Fishery Conservation & Management Act 200 miles sovereignty
- Russian factory ships cod dropped 50%
- Quota 5.9 million pounds

68 **Swordfish Morphology**

- *Xiphias gladius*
- Up to 15' and 1,180 lbs

69 **Swordfish Records**

- 25 years old 1,200 lbs
- Peak 1989 for catch
- Limit set in late 1990s minimum size 991
- 1997 58% of sustainable population caught
- 1985 \$13.3 / lb; tuna \$25/lb
- \$11.7 million dollars in 1985
- Now \$8.6/lb; tuna \$8.30/ lb

70 **Perfect Storm**

71 **Perfect Storm 1991**

72 **Perfect Storm 1991**

73 **Perfect Storm 1991**

74 **Grace's Storm Track in NE**

75 **Andrea Gail**

- Ships metacentric height lower worse no leverage to right the ship
- 60-70° angles gunwales underwater
- More weight to overcome
- 72' boat

76 **Andrea Gail's Course**

- Heads home after full moon catch around 23rd
- 28th 2PM from calm to 12' seas gusts at 15 knots
- Later pm wind direction changed 6:15 PM in middle of perfect storm
- Last coordinates 44' north 56.4' west
- Rest of fleet 45' N, 45'W
- Waves 30.5 m or over 100' bouy records
- Shoals off Sable Island some debris
- No ship ever found

77 33. Describe the circulation of currents at the Poles. Explain why large masses of ice break free and where they are carried. Explain why there are penguins in the Antarctic and polar bears in the Arctic, but not the reverse.

78 34. List and describe depositional geomorphological features of the coast.

- Spits
- Tombolos
- Bay barriers
- deltas
- Barrier islands

79 **Spits**

80 **Tombolo**

81 **Bay Barrier**

82 **Barrier Island**

83 **Deltas**

84 35. Explain how barrier islands are formed.

- 3 models
- Spits may become islands as sand retreats and there is migration of the headlands (hurricanes)
- Sediment compaction (like with peat in marshes) may cause some areas to sink and leave areas of deposition at the surf zone exposed as islands
- Shoals collect sediment from delta formation and become separated from mainland.

85 36. Describe the major physiographic zones of a barrier island.

86 37. Explain how delta formation differs from depositional features.

- Deltas are formed by silt/clay carried by the river to the ocean
- Aggregates when meet the ocean
- Other features are from deposition of sand due to wave or current movement along the coastline