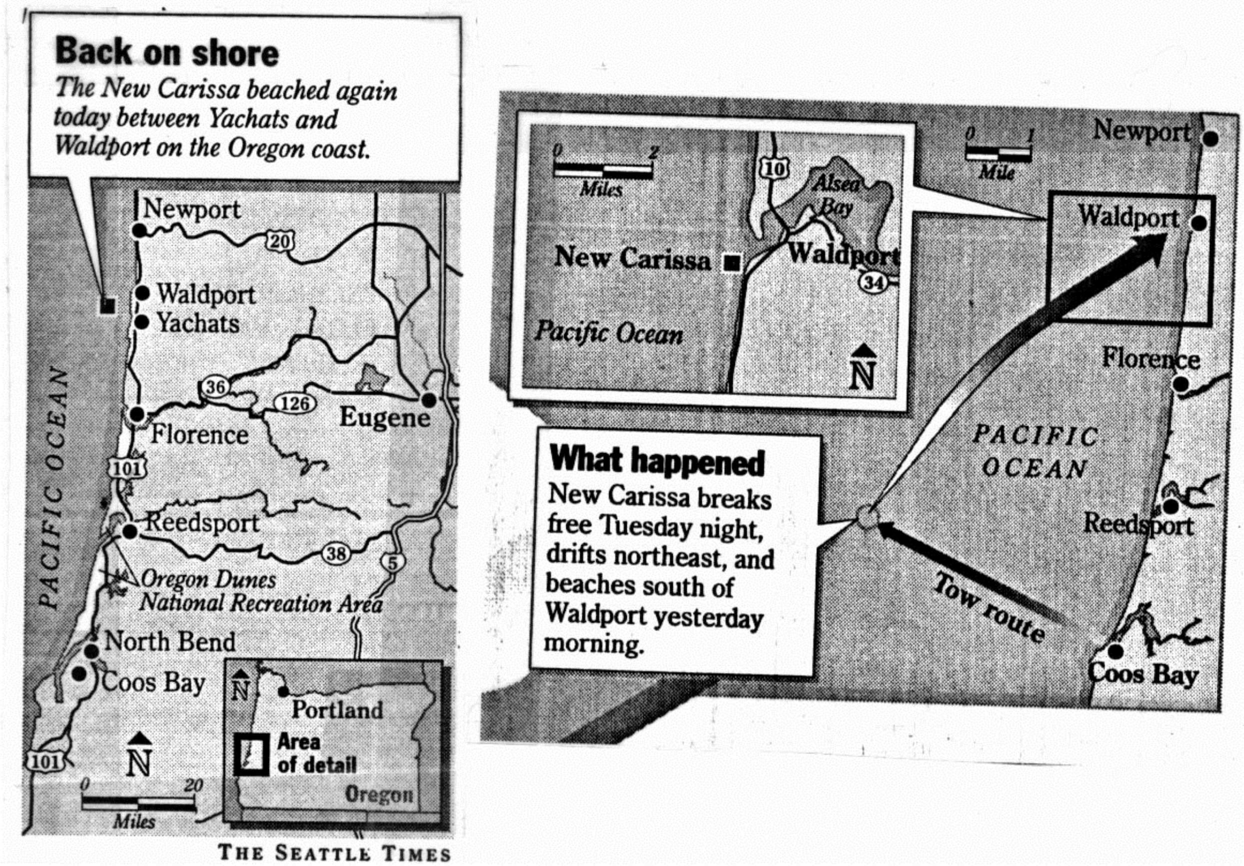
I. Winds & Currents (About 40 points, 20 questions)



The cargo ship *New Carissa* ran aground off the Coos Bay estuary on the Oregon coast during a sudden storm on February 4, 1999 (see figures). Oil began spilling from its ruptured fuel tanks and spreading across the coastal zone. Late on March 2, the broken bow section of the *New Carissa's* hull was being towed about 50 nautical miles offshore when the towline broke in a storm. The bow drifted to come aground again near the Alsea Bay estuary by the town of Waldport to the north (see map). Answer the following questions that relate to movements of the *New Carissa* and of oil spilled from its fuel tanks.

Be prepared to answer questions on the following topics relating to the locations on this map.

- Approximate compass and clock direction of wind blowing along the Oregon coast on March 3, and how you know
- Pattern of atmospheric pressure centers over the North Pacific Ocean and North American continent at the latitude of Oregon that would account for this wind direction
- How the atmospheric pressure pattern at this time of year is related to differences in thermal properties of land and water
- Complete account of the relationship of atmospheric pressure, Coriolis effect, and geostrophic processes to produce this wind pattern
- *Two factors used in calculating strength of the Coriolis effect*

Some of the fuel oil from the *New Carissa* had been in the tanks for a long time and was full of sludge. Upon entering sea water, this dense "bunker" oil would sink gradually below the surface. *The ship can be used as a tracer of water movement at the very surface of the water, and the bunker oil can be used as a tracer of water movement in the Ekman layer.*

- Complete account of how water movements *at the surface (New Carissa) and in the Ekman layer (bunker oil)* would respond to this sudden storm, especially:
  - Differences between speed & direction of surface water flow & oil drifting as it sinks to different depths *in the Ekman layer*, and why
  - *Difference between movement of the surface water and the Ekman layer as a whole*
- Responses of coastal sea level and upwelling/downwelling to this pattern of water movement
- *Difference between these flow characteristics and the long-term geostrophic flow pattern*
- *Definition and properties of ocean gyres*

Suppose that the *New Carissa* towline had snapped at the same location on an average day in **July** instead of on March 2.

- Differences in atmospheric pressure pattern and wind direction, and reasons why
- Differences in direction of drift of *New Carissa* and spilled bunker oil, and reasons why
- Responses of coastal sea level and upwelling/downwelling to this pattern of water movement
- Name, direction, & properties of prevailing *geostrophic* ocean current that is present at all times of year in this region

Suppose that the *Old Carissa*, a ship like the *New Carissa*, had run aground during **July** along the Japan coast.

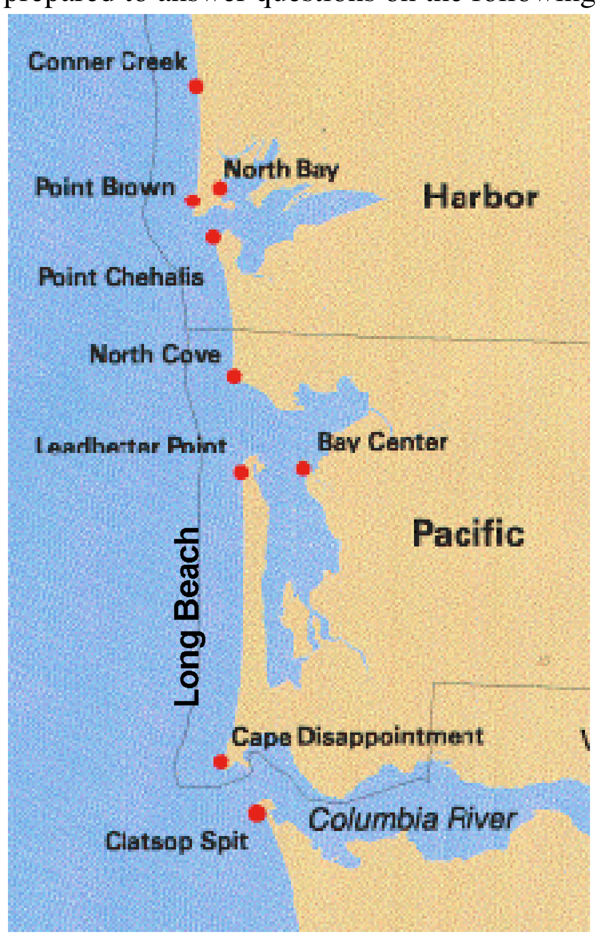
- Approximate compass and clock direction of wind blowing along the Japan coast in July, and how you know
- Pattern of atmospheric pressure centers over the North Pacific Ocean and Asian continent at the latitude of Japan that would account for this wind direction, and reasons why
- Complete account of the relationship of atmospheric pressure, Coriolis effect, and geostrophic processes to produce this wind pattern
- Name, direction, & properties of prevailing ocean current that is present at all times of year in this region
- Differences in direction, speed, depth, & other properties between prevailing *geostrophic* ocean currents along Japan & Oregon in July, and reasons why
- Differences in upwelling/downwelling, sea surface slope, and geostrophic processes between prevailing ocean currents along Japan & Oregon in July, and reasons why
- Effects of eastern & western boundary currents on local weather & climate

II. El Niño (About 10 points, 5 questions)

- *"Normal" (La Niña) conditions of atmospheric pressure, precipitation, trade winds, convection, sea surface temperature, sea surface elevation, and upwelling/downwelling in the equatorial Pacific, and processes that produce these conditions*
- *Changes in conditions of atmospheric pressure, precipitation, trade winds, convection, sea surface temperature, sea level and upwelling/downwelling in the equatorial Pacific that occur during El Niño*
- *Weather impacts of El Niño in NW & SE USA, California, Peru region, Indonesia region*
- *Technology used to monitor ˜Niño conditions in the Pacific*
- *SOI & distinction between "normal" and average conditions in the equatorial Pacific*

II. Coastal Processes (About 40 points, 20 questions)

You are hired by Shady Enterprises, Inc., as a coastal oceanographic consultant to advise them on building a new beachfront condo development on the Long Beach Peninsula along the coast of Washington, about 150 miles north of where the *New Carissa* ran aground. The natural sediment composition of Long Beach is nearly 100% sand*, except for Cape Disappointment, a rocky headland*. The last hydroelectric dams on the nearby Columbia River were completed during the 1970s. Until about 1980, Long Beach was accreting, but today it is eroding rapidly. Be prepared to answer questions on the following topics relating to the locations on this map.



- Terminology for natural shoreline formations
- Terminology of sediment transport processes
- Long-term average compass direction of average wave & sediment transport, and how you know
- Seasonal changes in compass direction of average wave & sediment transport, and how you know
- Which season has the dominant effect on shaping this shoreline, and why
- Seasonal changes in beach profile and sediment grain size, & reasons for them
- Special wave conditions at the Columbia R. mouth, & reasons for them
- Possible reasons for change from deposition to erosion on Long Beach since about 1980
- *Comparison of wave energy, refraction, diffraction, & reflection at Cape Disappointment vs. Bay Center*

Suppose that Shady Enterprises proposes several alterations to the natural shoreline on the ocean coast of Long Beach to enhance the shoreline for a resort it wants to build.

- Location, purpose & effects of building a groin, and reasons why
- Purpose & effects of building a seawall, and reasons why
- Purpose & effects of building a breakwater for a marina, and reasons why
- Purpose & effects of dredging the marina, and reasons why
- ~~Location, purpose & effects of dumping the dredge "spoils," and reasons why~~

IV. Deep-Ocean Waves (About 20 points, 10 questions)

Suppose that you are the marine forecaster on the Washington Coast, and you must warn Long Beach residents about a severe winter storm such as the one that grounded the *New Carissa*. Be prepared to answer questions about what happens to waves from such a storm as they are generated in the deep ocean, pass into shallow water along the Washington shelf, and finally break in the surf zone. Assume that the waves are in deep water unless *told otehrwise*.

- General pattern of water & energy movement in deep- & shallow-water waves
- Factors controlling the height of waves generated by a storm
- Definitions of wave heights as reported in marine forecasts
- How ocean swell develops from storm waves, and reasons why
- Wave properties needed to make marine forecasts, & how they are measured and reported
- General relationship of wave properties to wave crest speed and group velocity
- Approximate conditions under which waves break in deep water and shallow water
- Changes that take place in wave properties *(length, height, speed, period, steepness)* as waves pass over the shelf toward shore, and reasons why
- *Formulas for key* depths at which these changes take place

Additional Vocabulary

Agulhas Current	Anomaly	Bar conditions
Barrier island	California, Peru, Canary C.	Celerity
Cold-core rings	Combined seas	Condensation
Convection cell	Convergence	Coriolis Effect
Deep-water wave	Deposition	Divergence
Eastern boundary currents	Ekman transport	ENSO
Equatorial Currents	Erosion	Fetch
Fully developed seas	Group velocity	Gulf Stream & Kuroshio C.
Gyre	Heat capacity	Isobars
Latent heat	Longshore transport	N. Atlantic & N. Pacific C.
Period	Polar Easterlies	Prevailing Westerlies
Rip current	Rogue Wave	San spit
Sea surface elevation contours	Shallow-water wave	Shoal
Significant height	Southern Oscillation Index	Storm surge
Subpolar	Subtropical	Surf zone
Swell	Tombolo	Transition/intermediate wave
Warm pool	Warm-core rings	Wave dispersion
Wave steepness	Wave train	Wavelength
Western boundary currents	Western Intensification	Wind waves