Deepwater Horizon Gulf Oil Spill

Coastal Response Research Center
University of New Hampshire

Nancy E. Kinner

January 18, 2011
GeoLunch Series, Bates College
Caveats

• Not Detailed Description of Deepwater Horizon (DWH) Spill

• Not Detailed Description of Short Term Spill Impacts
  ➢ Long-term not known yet

• Not Overview of Spill R&D Needs

• Not Details of Testifying with Kevin Costner and media circus of DWH
Today’s Topics

• Crude Oil Basics
• Overview of DWH Spill
• State-of-the-Art Spill Response: Exxon Valdez (Nothing has changed since 1989!)
• State-of the-Art Spill Response: DWH
• Some Issues in DWH
• Will Anything Change Going Forward?
Crude Oil Basics
Crude Oil Properties

• Usually Floats on Water
  • May sink if associated with sediment particles

• Composition Varies with Source
  • Louisiana Sweet Crude Oil – lighter than Alaska North Slope crude

• Some Solubility
  • Soluble is most toxic fraction

• 250+ Hydrocarbons
  • Mostly carbon and hydrogen
Weathering of Oil

- Natural Processes
- Function of Environmental Conditions
  - Temperature (H₂O, Air)
  - Wind
  - Oil Type
  - Currents, Tides
Overview of DWH Spill
Overview of DWH Spill

- DWH Rig Had Finished Drilling Well ~50 miles Off Mississippi River Delta
  - 5,000 ft of water
  - 13,000 ft of sediment/rock
  - Total rig to oil reservoir ~ 18,000 ft (~3.5 miles)

- April 20 – Explosion on Rig/Fire/11 Killed

- July 15 – Well Killed from Top Ending Release

- Total Oil Release (est.) = 200 Million Gallons

- Largest ACCIDENTAL Oil Spill in Recorded History!
Initial Response Mode
Final Response Mode: Prior to Top Kill

Coastal Response Research Center
State-of-the-Art Spill Response: 
*Exxon Valdez*

“Nothing Changed from Exxon Valdez to DWH!”
State-of-the-Art Spill Response: 
*Exxon Valdez*

  - Released 11 million gallons of North Slope crude in few days
  - Slow response due to remote location (lack of equipment) and poor weather
  - Much shoreline coated with oil
  - Wildlife deaths high
    - e.g., 100,000 – 300,000 birds
    - DWH < 5,000 birds

Coastal Response Research Center
State-of-the-Art Spill Response: Exxon Valdez

- Response Techniques:
  - Skimmers and booms
  - Shoreline cleaning
  - Natural weathering of oil
Oil Collection Boom
Oil Collection Boom
Skimmers and Booms
Skimmers and Booms
Shoreline Cleaning
Weathering of Oil

- Wind
- Drifting
- Photolysis
- Evaporation
- Spreading
- Water-in-oil emulsion
- Resurfacing of larger oil droplets
- Dissolution of water soluble components
- Uptake by biota
- Adsorption to particles
- Microbiological degradation
- Vertical diffusion
- Horizontal diffusion
- Sedimentation
- Uptake and release from sediment

Coastal Response Research Center
Exxon Valdez: Did It Really Change Anything?

- Oil Pollution Act 1990 (OPA 90)
  - Double hulled tankers mandatory
  - Unified Command of response
    - Coast Guard lead
  - Response plans required
    - Industry, state, federal
    - Drills and exercises required
Exxon Valdez: Did It Really Change Anything?

- Natural Resource Damage Assessment (NRDA)
  - Compensate natural resources (e.g., environment) and public for damage/loss
- R&D Funding
  - Federal, state, industry
  - OPA 90 Authorized $30 million R&D Funding
    - Little appropriated = $5.2 million
Exxon Valdez: Did It Really Change Anything? (20 Years Later)

- “We Don’t Have Big Oil Spills in the U.S. Anymore”
  - Cosco Busan (2007) in San Francisco Bay = 56,000 gallons with rapid response and little impact
    - Too many untrained volunteers
- Hurricanes: Katrina and Rita
  - 8 million gallons oil spilled
  - Some big releases of >1 million gallons
  - Lost in amid news of human tragedy
Exxon Valdez: Did It Really Change Anything?

R&D Funding vs. Time

\[ S_t = S_o e^{-kt} \]

Coastal Response Research Center
Exxon Valdez: Did It Really Change Anything?

Public Interest in Oil Spills vs. Time

Time (years)

U.S. Public Interest in Oil Spills

Estimated Footprint (DWH vs. Valdez)

Estimate of Exxon Valdez oil footprint ~470 mi by 50 mi
DWH Response:
200 million gallons of oil released over 87 days
Lots of Oil Over Long Time
“We faced a new spill every day for 3 months!”
Priority #1 = Stop Fire, Rescue People
Priority #2 - Stop Source of Leak

• Start Relief Well
• Install “Cap” to Stop Flow
  • High ambient water pressure, cold and dark
    • 2200 psi
  • High exit pressure of oil, hot (212°F)
    • 6500 psi
• Well Head ~ 7 inches diameter; 1 mile below water’s surface
Priority #3 - Identify Natural Resources at Risk

- Crabs, Shrimp, Oysters, Blue Fin Tuna, Charismatic Marine Mammals
- Recreational Beaches
- Commercial Fishing
- Subsistence Fishing

Shorelines on ESI maps are color-coded by sensitivity to oil. Symbols mark localized areas for biological and human-use resources.
Priority #4 – Minimize Damage to Natural Resources

- Protective Booms
  - ~5,500 miles of boom deployed
- Capture Oil in Booms (Mechanical Recovery)
  - Skim oil off surface
  - Burn oil on surface
- Disperse Oil
- Weathering of Oil
  - Evaporation
DWH: State-of-the-Art
DWH: State-of-the-Art Mechanical Recovery

- Lots of Vessels & Boom
- Improved Designs (since Exxon Valdez)
- Weather Was **Not** Conducive to Mechanical Recovery
  - 20+ mph winds and 3+ft waves on-shore
- Encounter Rate Low – Big Plume
- No Night Skimming
DWH: State-of-the-Art Rising Plume Effect

- Rise = 1 mile from Well to GOM Surface
- Plume on Surface = 100 mi long
- Swath Width per Skimmer = 200-500 ft
- Multiple Boats – 1750 ft
DWH: State-of-the-Art In Situ Burning

- Not Used in Exxon Valdez
- Lots of R&D Since Exxon Valdez
- Protocol/Standards
  - Fire Retardant Boom
  - Ignition
  - Oil thickness
DWH: State-of-the-Art Dispersants

- Not Used in Exxon Valdez
- Waves Mix Dispersant with Oil
- Dispersant Breaks Up Oil Plume into Tiny Oil