



Oil 101

Basic Description of Oil and Its Environmental Impacts

Dr. Phillip Lee

Gulf Coast Research Laboratory & University of Southern Mississippi
Ocean Springs, Mississippi

Oil 101

What is oil?

Webster Definition- any of numerous unctuous (greasy feeling) combustible substances that are liquid or can be liquefied easily on warming, are soluble in ether but not in water, and leave a greasy stain on paper or cloth.

Types of Oils- One of three kinds of substances:

- (1) mineral oils, such as crude oil from petroleum, which are mixtures of hydrocarbons;
- (2) animal and vegetable oils, such as corn oil, which are mixtures of triglycerides; and
- (3) essential oils or perfumes from plants.

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Crude Oil- Mixture of naturally occurring hydrocarbons that is refined into diesel, gasoline, heating oil, jet fuel, kerosene, and literally thousands of other products called petrochemicals. Crude oils are named according to their contents and origins, and classified according to their per unit weight (specific gravity). Heavier crudes yield more heat upon burning, but have lower API gravity and market price in comparison to light (or sweet) crudes.

Petroleum- A thick, flammable, yellow-to-black mixture of gaseous, liquid, and solid hydrocarbons that occurs naturally beneath the earth's surface, can be separated into fractions including natural gas, gasoline, naphtha, kerosene, fuel and lubricating oils, paraffin wax, and asphalt and is used as raw material for a wide variety of derivative products.

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Basic Chemistry

Elements-

C, H

Compound-

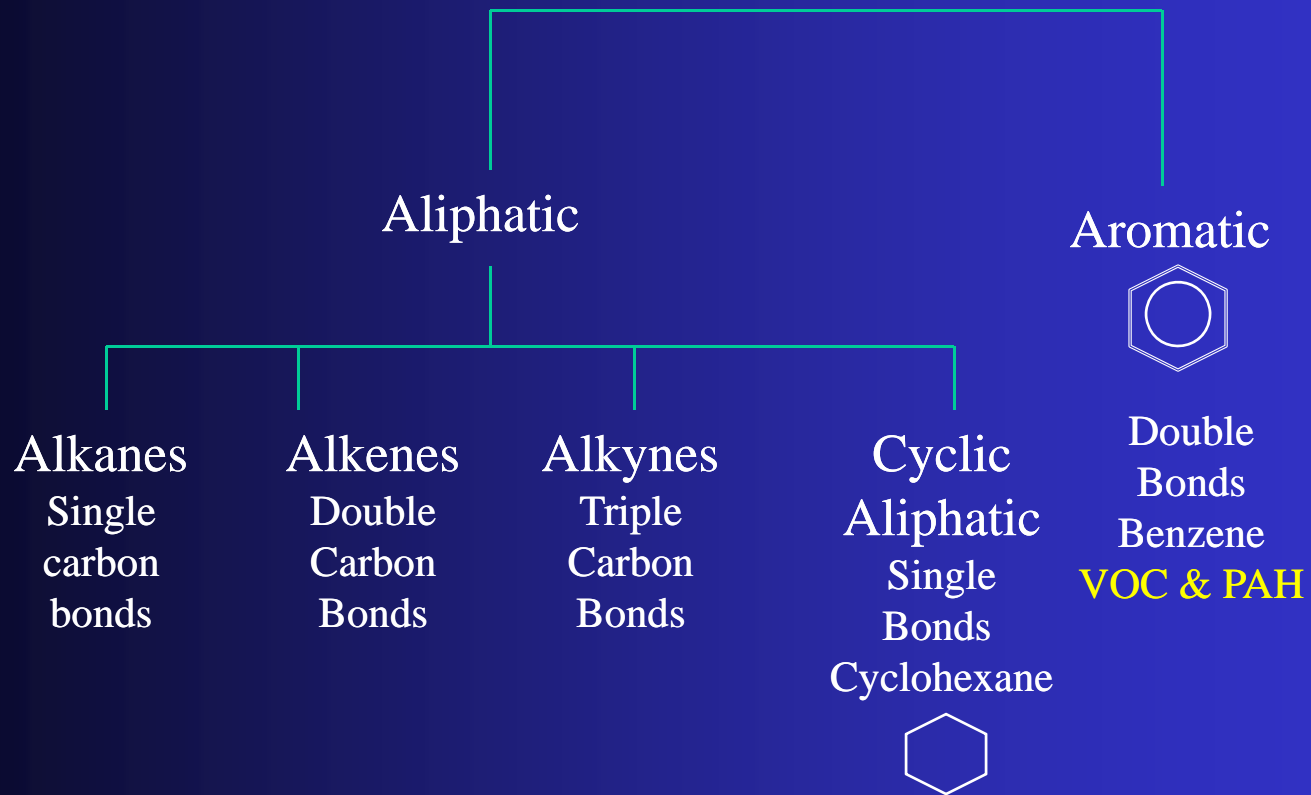
Octane or C_8H_{18}

Substance or Mixture-

Crude Oil
Cooking Oil
Baby Oil

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Hydrocarbons



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Hydrocarbons

Methane- CH_4

Ethane- $\text{CH}_3\text{-CH}_3$

Natural gas

Propane- $\text{CH}_3\text{-CH}_2\text{-CH}_3$

Octadecane- $\text{CH}_3\text{-CH}_{2(16)}\text{-CH}_3$

Petroleum

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Petroleum Constituents

Fraction	Carbon Number
Gas	C ₁ -C ₄
Petroleum Ether	C ₅ -C ₆
Light Naphtha	C ₆ -C ₇
Natural Gasoline	C ₅ -C ₁₀
Kerosine	C ₁₂ -C ₁₈
Gas Oil	C ₁₂ & higher
Lubricating Oil	Long chains w/cyclic compounds
Asphalt	Polycyclic compounds

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Characteristics of the Gulf of Mexico & Oil Exploration and Production

- Significant contribution to domestic oil production
 - **>\$124 B/yr**
 - 29% of crude oil
 - 12% of natural gas
 - 55,000 workers
- >4,000 oil platforms in the Gulf
- **>60% of US petrochemical industry located along Gulf coast**
- >600 Natural oil seeps
- The most valuable fishery for the US
 - **<\$1 B/yr** commercial landings
 - **>\$12 B/yr** with 3.2 M recreational fisherman and 24 M trips/yr
- Important access for transportation and tourism
 - 7 of US's top 10 ports
 - **\$100 B/yr** in tourism

Gulf of Mexico Oil Platforms

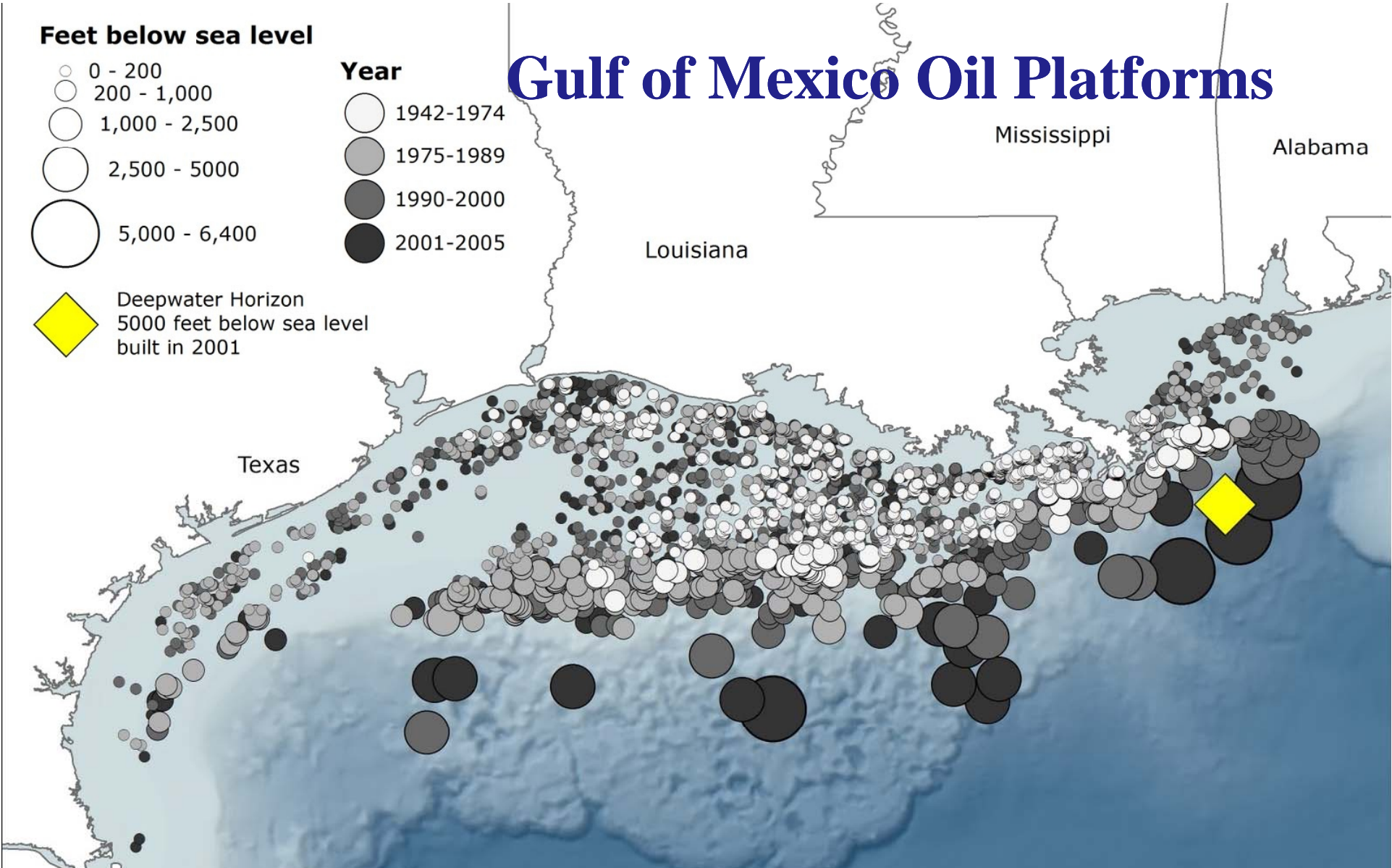
Feet below sea level

- 0 - 200
- 200 - 1,000
- 1,000 - 2,500
- 2,500 - 5,000
- 5,000 - 6,400

Year

- 1942-1974
- 1975-1989
- 1990-2000
- 2001-2005

◆ Deepwater Horizon
5000 feet below sea level
built in 2001



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Deepwater Horizon Oil Spill Facts

- April 20, 2010
- **1,554 m or 1 mile deep**
- Gulf of Mexico Mississippi Canyon
- **Released 4,900,000 barrels of oil**
- Oil plume detected 1,100-1,500 m deep as well as at surface
- **Several dispersants used at highest rates in history to accelerate oil dispersal**
- Oil composed of aliphatic compounds, benzene, toluene, ethylbenzene & xylene



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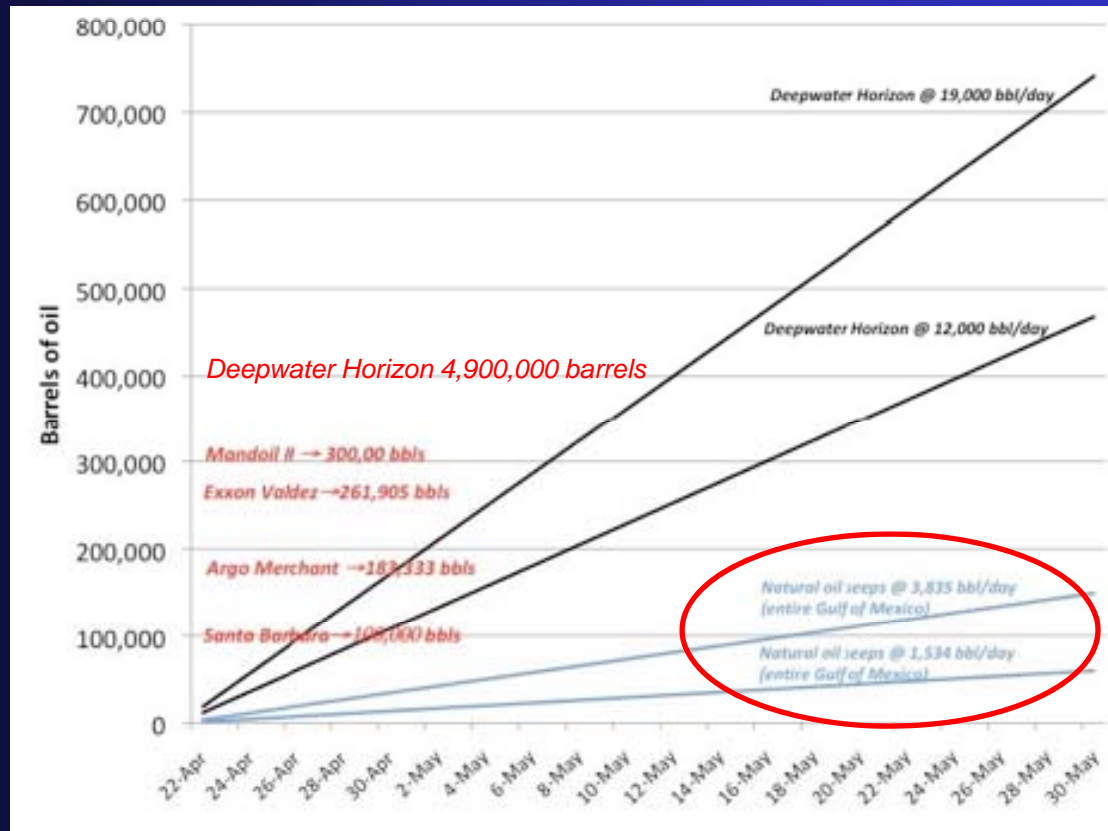


Figure 1. Estimates on the quantity of oil released from the Deepwater Horizon accident, from natural oil seeps in the entire Gulf of Mexico, and from some notable historic U.S oil spills.

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Mississippi Delta

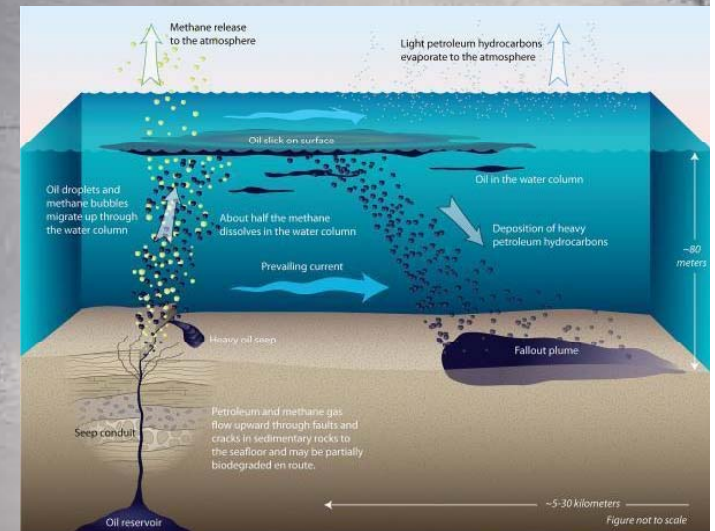
"The ocean will take care of this on its own if it was left alone and left out there. It's natural. It's as natural as the ocean water is." -Rush Limbaugh, 5/3/10.

Natural Oil Seeps >600

Gulf of Mexico



"**natural**" does not equal "**good**." It *can*, and in advertisements it always does, but in reality, the two words are not synonymous.



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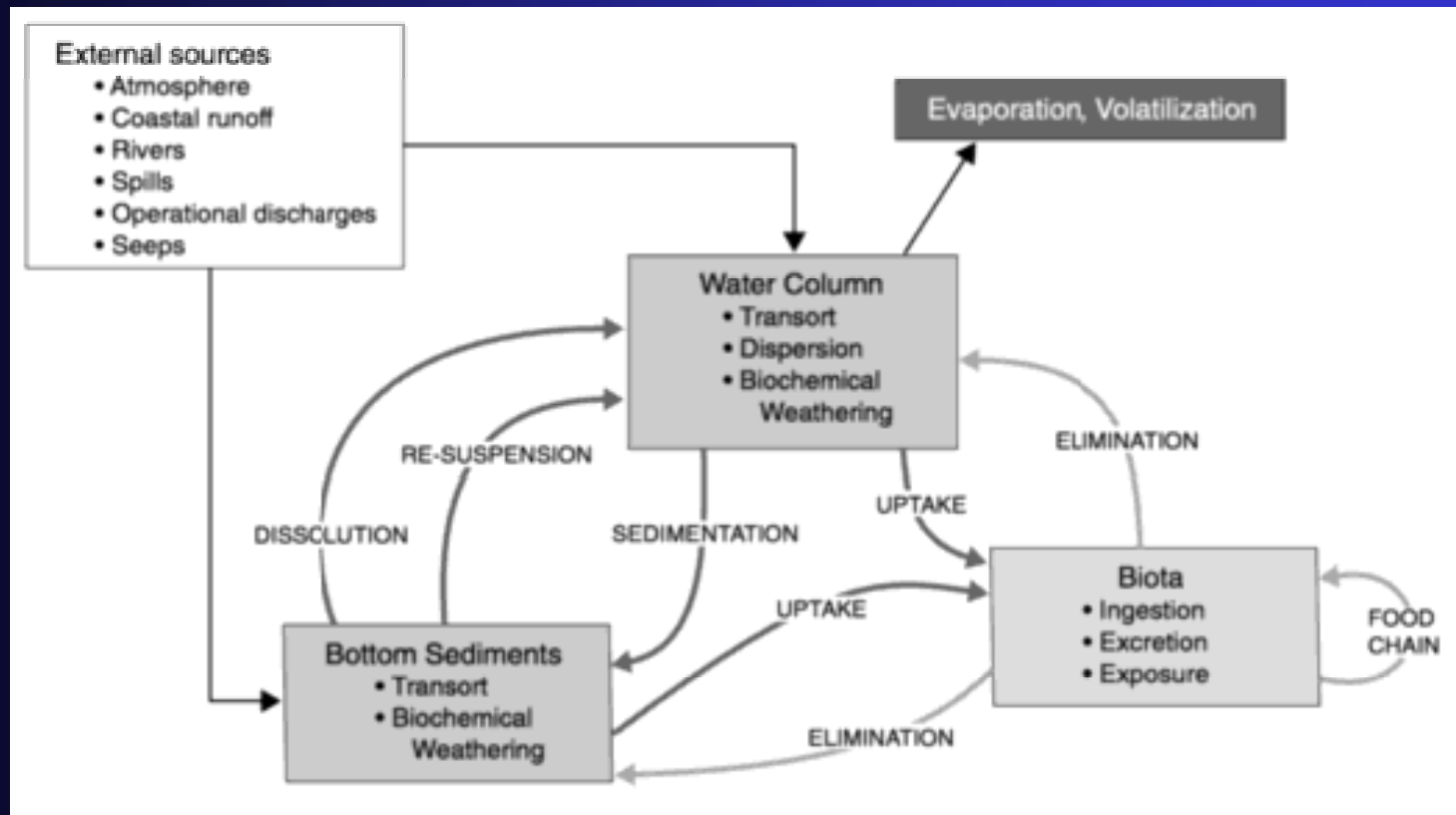
Deep Horizon Oil Characteristics



1. Fingerprinted as MS252
2. Composed of thousands of compounds
3. Compared to most crude oil MS252 is high in alkanes
4. MS252 is more likely to biodegrade due to alkanes
5. MS252 is less toxic than most crude oil because it is low in Polyaromatic Hydrocarbons (PAHs)
6. PAHs are highly toxic and persist in the environment
7. MS252 contains Volatile Organic Compounds (VOC) that are acutely toxic
8. VOCs evaporate rapidly and cause toxicity only in fresh crude

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Oil Transport and Fate In the Ocean



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Deep Horizon Oil Transport and Fate

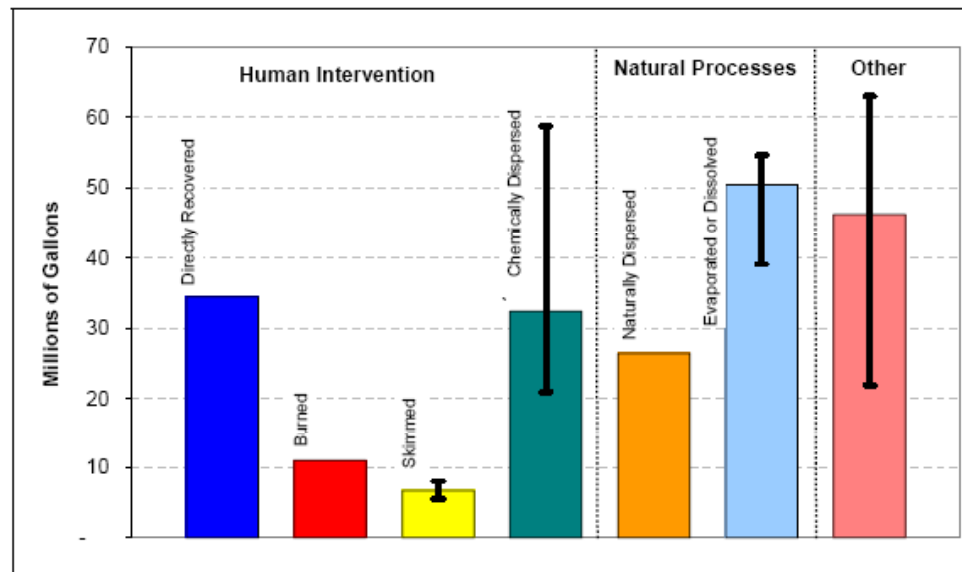
1. Dispersion
2. Removal
 - Burning
 - Skimming
3. Mixing
4. Biodegradation



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Dispersants vs Biodegradation

Figure 5. Federal Government Oil Budget Estimates and Ranges of Uncertainty
Based on July 14, 2010 Estimates



Source: Prepared by CRS using estimates provided the Federal Interagency Solutions Group, Oil Budget Calculator Science and Engineering Team, Oil Budget Calculator: Deepwater Horizon-Technical Documentation, November 2010, p. 39.

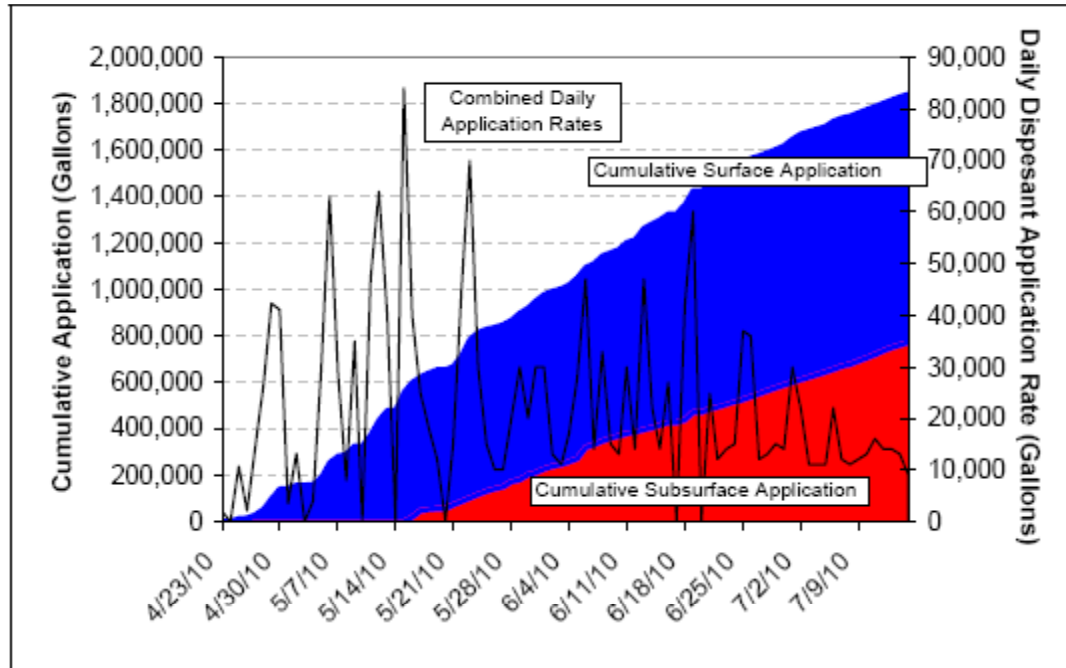
Notes: The columns illustrate the “expected” case estimates. The uncertainty bars represent the range between the best and worst case scenarios. Although the data (from Figure 12) used to generate the uncertainty ranges above showed no such range for the “naturally dispersed” category, the text of the Technical document discusses an uncertainty factor for both natural subsurface and natural surface dispersion.

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Deep Horizon Oil Transport and Fate

Figure 4. Surface and Subsurface Chemical Dispersant Application during the 2010 Gulf Oil Spill

Cumulative Application



Source: Prepared by CRS with data from daily "Current Operations" updates, available at <http://www.restorethegulf.gov/>.

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Larger crude-oil accumulations such as pancake oil (round, flat accumulations of heavy crude oil) and tar balls (weathered crude oil accumulations that have been formed into ball-shaped structures) are deposited on the beach. Meanwhile, liquid oil (in the form of an oil sheen, or small dispersed droplets) can penetrate many feet deep into the permeable beach sand.

“Weathered crude oil found to be 2-24 times less toxic than fresh crude oil.”



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Biodegradation

1. Oil dramatically altered the microbial community- abundance and activity
2. Microbial community was diverse
3. Microbial community were able to respond to the oil spill
4. Aliphatic compounds are most easily assimilated
5. Saturated compounds are degraded more readily than unsaturated ones
6. Branched-chain compounds are degraded less readily
7. Aromatic compounds may be oxidized but are assimilated by few bacteria



Before adding bacteria

7 days later

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Dispersants vs Biodegradation

The problem, explains Hodson, "is that the dispersed cloud of microscopic oil droplets allows the PAHs to contaminate a volume of water 100–1,000 times greater than if the oil were confined to a floating surface slick."

"It is important to remember that oil is a biological product and can be degraded by microbes, both on and beneath the surface of the water," Hazen says. "Some of the detergents that are typically used to clean-up spill sites are more toxic than the oil itself, in which case it would be better to leave the site alone and allow microbes to do what they do best."

"The untreated coastal areas were fully recovered within five years of the Amoco Cadiz spill," says Hazen. "As for the treated areas, ecological studies show that 30 years later, those areas still have not recovered."

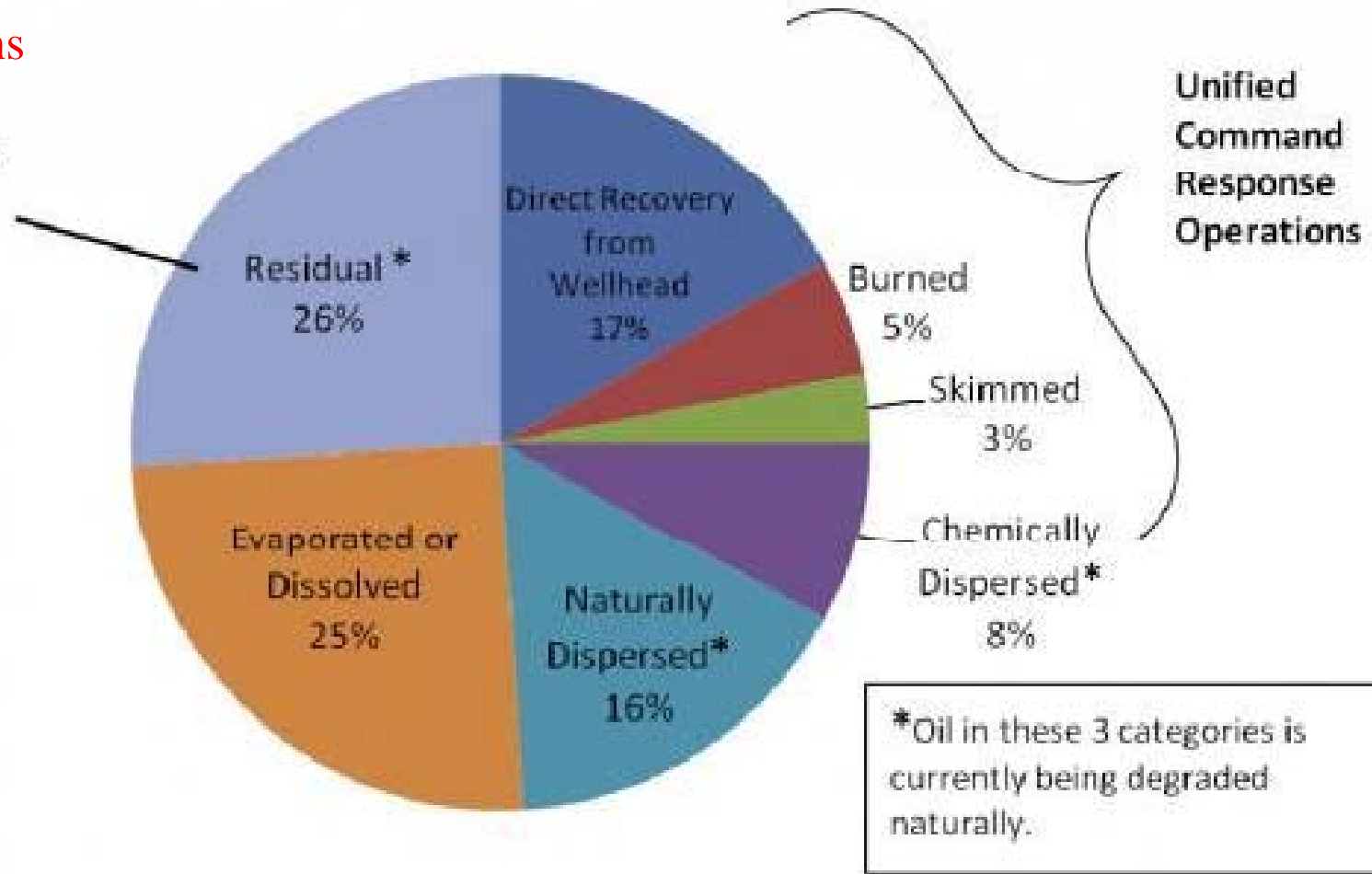
So, Are the dispersants a part of the solution or a part of the problem?

Deepwater Horizon Oil Budget

Based on estimated release of 4.9m barrels of oil

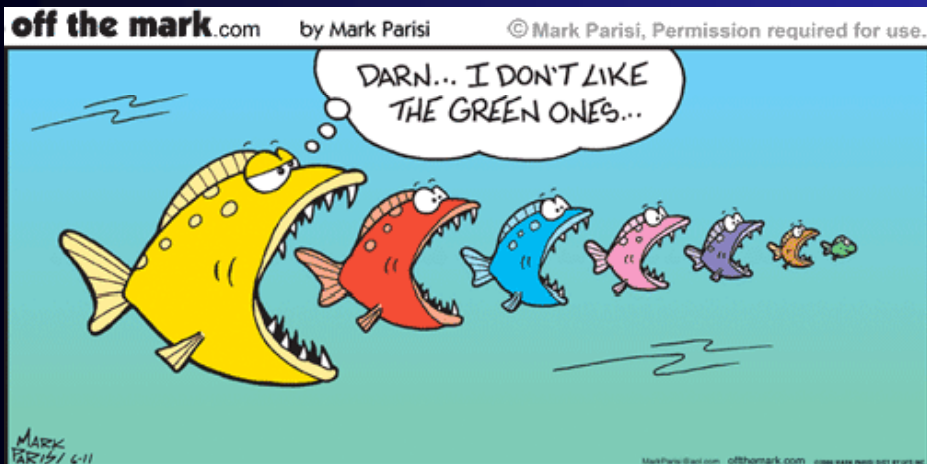
1.1 Billion Gallons

Residual includes oil that is on or just below the surface as light sheen and weathered tar balls, has washed ashore or been collected from the shore, or is buried in sand and sediments.



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Deep Horizon Oil Possible Effects



1. Acute toxicity to fish, birds, mammals and shellfish by direct contact of oil
2. Acute toxicity to fish, birds, mammals and shellfish by direct contact of dispersant
3. Lower productivity due to toxicity of oil and dispersant to phytoplankton and zooplankton
4. Chronic toxicity due to bioaccumulation through the food chain including humans
5. Expanded dead zones due to increased oxygen demand for degradation of oil compounds