Remediation of Louisiana Coastal Environments Impacted By MC 252 Oil: Natural Recovery or Active Strategies?

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Collaborators

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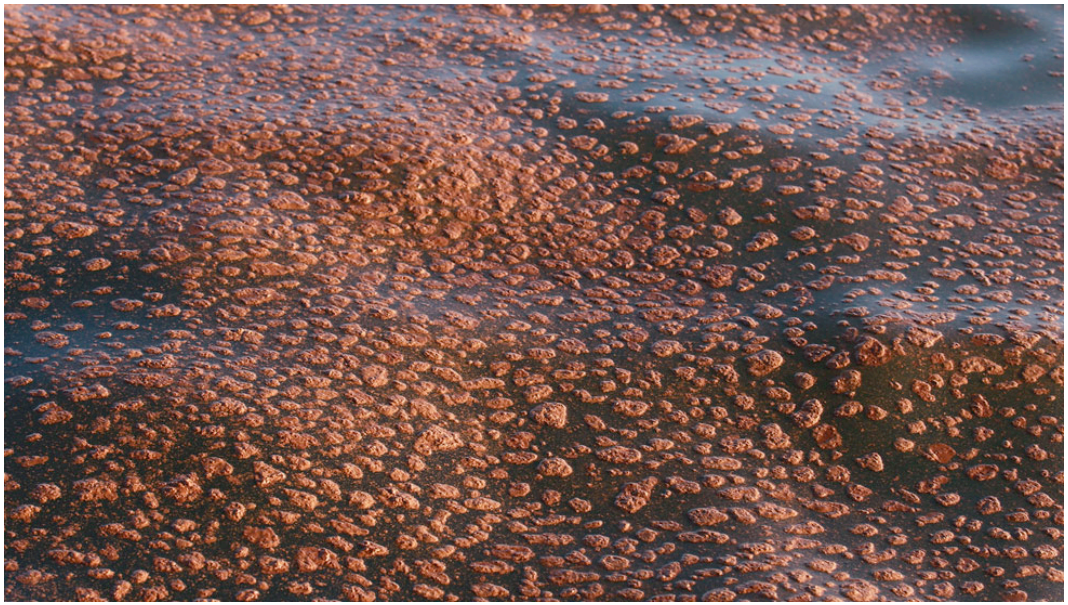
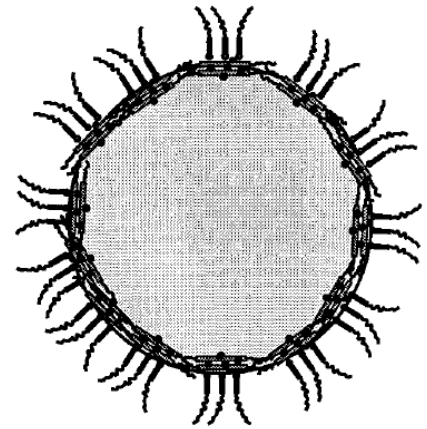
Questions

- What is different about the fate, transport and dissipation of the emulsified oil that reached Louisiana's coast?
- Which coastal environments have the potential to have slow rates of natural recovery?
- What is an appropriate endpoint for active remediation efforts in Louisiana coastal environments?

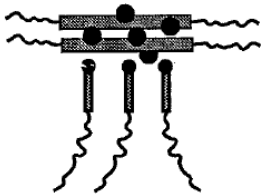
Emulsion or “mousse”- primary form of oil at coast



Stability of oil:water emulsions

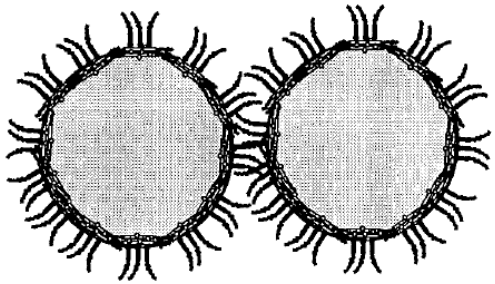


Asphaltene-Stabilized Water Droplet



Partially Resin-Solvated
Asphaltene Aggregate

Stable emulsions form due to surface-active components: asphaltenes and resins



Droplets Resist Fusion
Due to Steric Stabilization

From McLean and Kilpatrick, 1997

Spill: *Metula*
Date: 1974
Location: southern Chile
Remedial Action: None
Result: Large areas still unvegetated due to heavy oil accumulation at surface.

Washout of DH oil from Hurricane Alex and TS Bonnie 2010

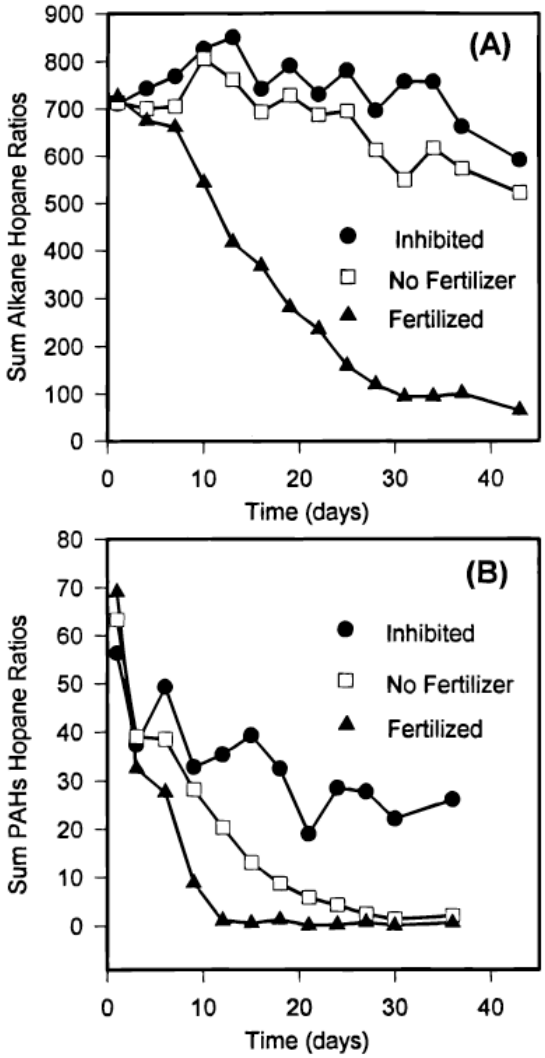
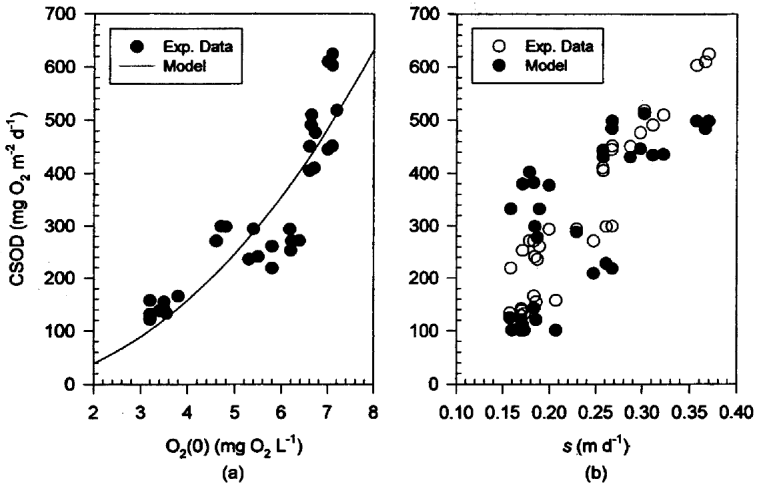
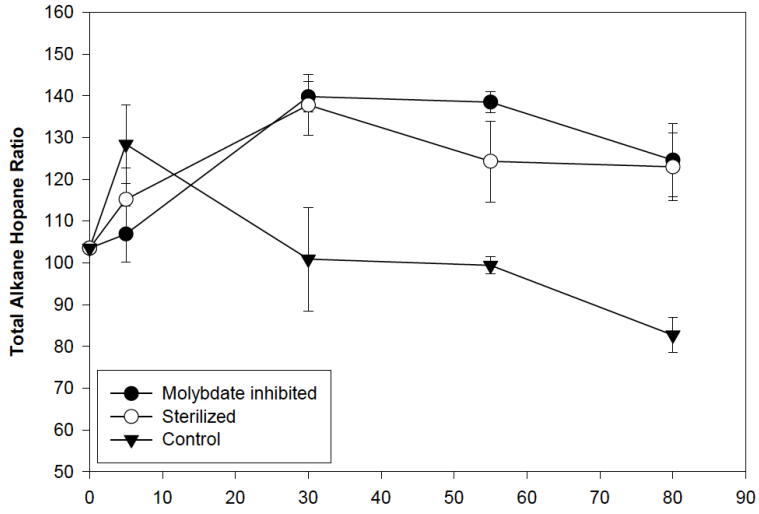


FIGURE 1. (A) Total (C15–C44) alkane hopane ratio versus time in aerated microcosms. (B) Total PAH (phenanthrene, C1–C2; naphthalene, C1–C2) hopane ratio versus time.

Aerobic biodegradation



Geochemical biodegradation modeling



Anaerobic biodegradation

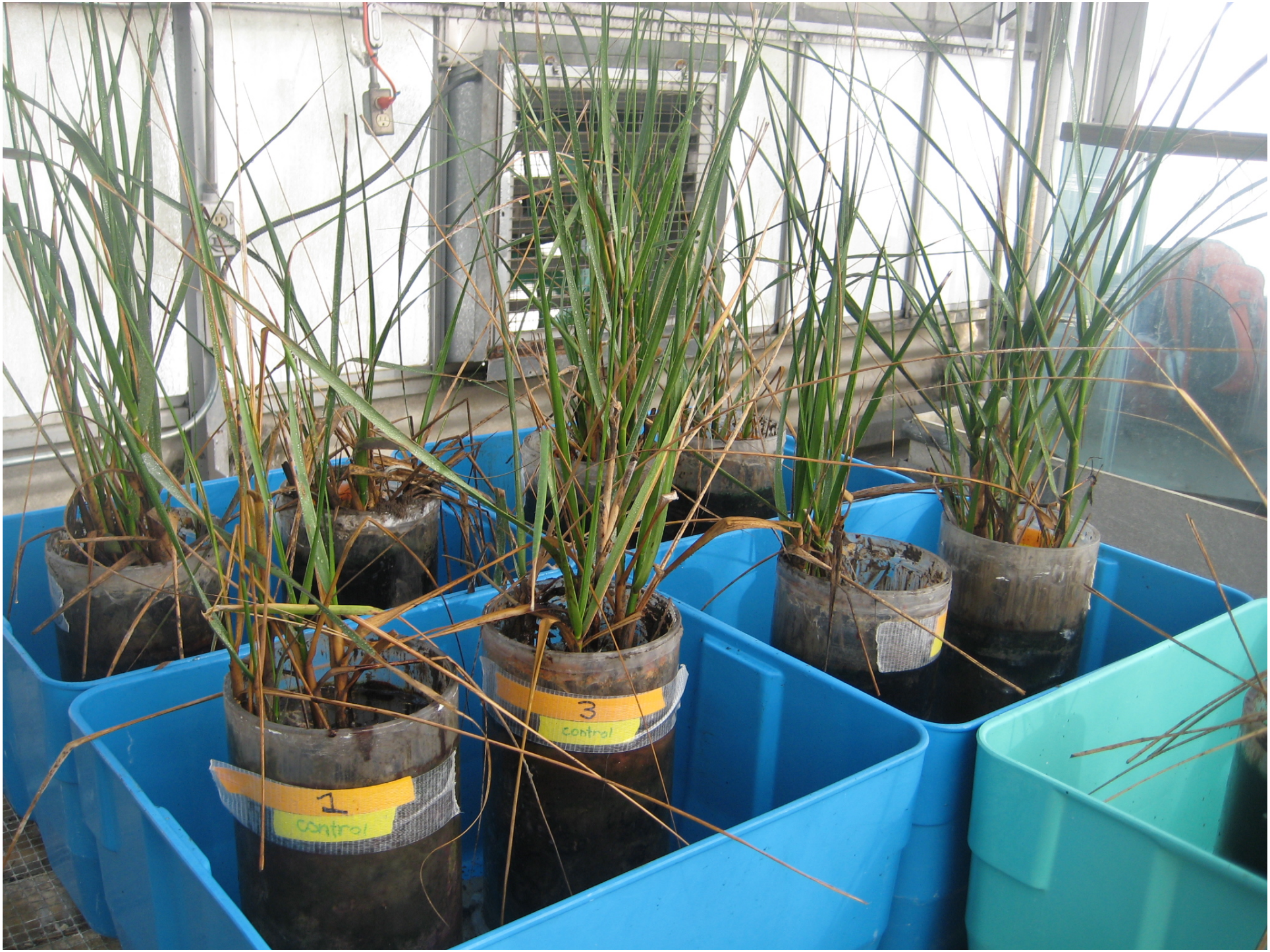
Ongoing studies

1. Enhancing biodegradation of DH emulsified oil in salt marsh cores

   We are conducting greenhouse experiments on the fate of Deep Horizon emulsified oil in replicate salt marsh cores. We are investigating the rate of natural breakdown of the oil and the impact of adding nutrients. We have data to discuss from this study.

2. Anaerobic vs aerobic biodegradation profiles of DH crude oil in marsh soils.

   We are conducting controlled atmosphere microcosm studies that examine the degradation profile of DH oil under aerobic and anaerobic conditions. We are identifying the residual oil "signature" after biodegradation under aerobic or anaerobic (sulfate-reducing) conditions. This study is ongoing and we expect to have results at the end of August 2010.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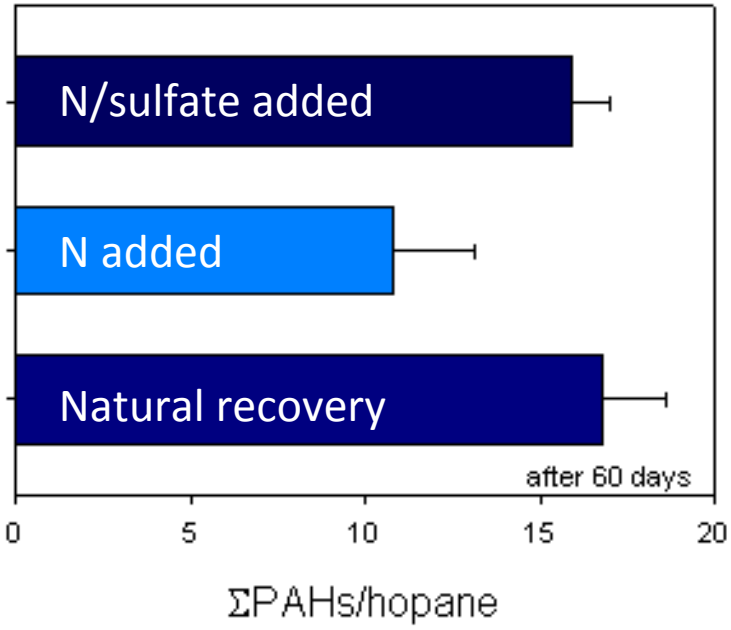
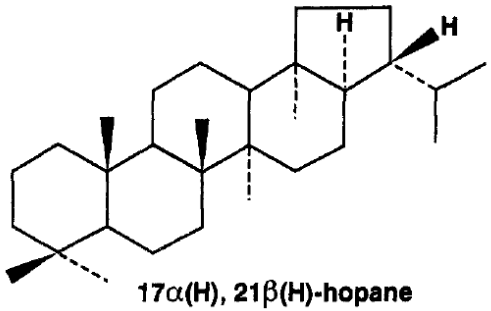
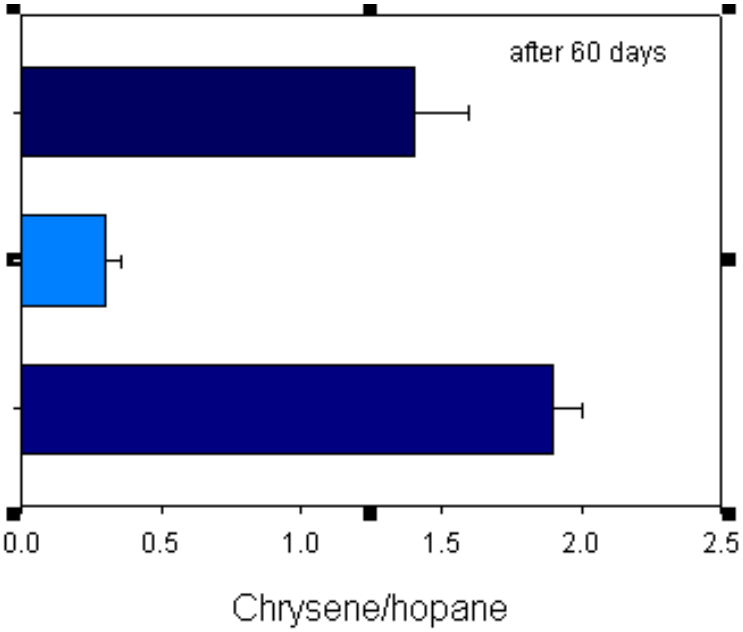
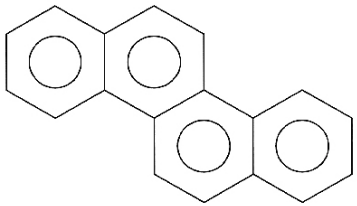




17α(H), 21β(H)-hopane





Chrysene
$C_{18}H_{12}$

Ongoing studies

3. Use of stable isotope technique to measure crude oil mineralization.

   We are using a technique we developed to non-invasively measure the mineralization of crude oil in salt marshes. The technique uses a chamber to trap carbon dioxide being released from the marsh surface and is able to detect CO_2 from crude oil (released as bacteria convert it to CO_2) and distinguish it from CO_2 from organic matter from *Spartina*. This study is ongoing and we expect to have results at the end of August 2010.

4. Fate of oil on vegetation

   We are investigating the oil on the surface of *Spartina* vegetation and the factors that lead to the oil desorbing from the vegetation. In addition, we are assessing the biodegradation of oil on the vegetation surface. This study is ongoing and we expect to have results at the end of September 2010.

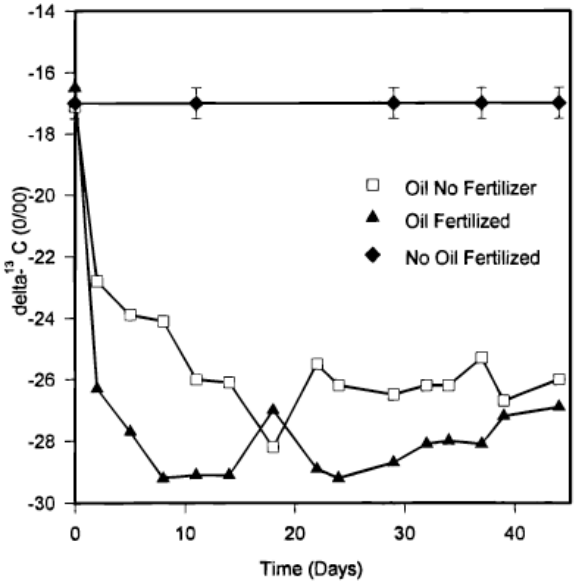


FIGURE 2. δ-^{13}C signatures (‰) of CO_2 versus time in aerated microcosms.

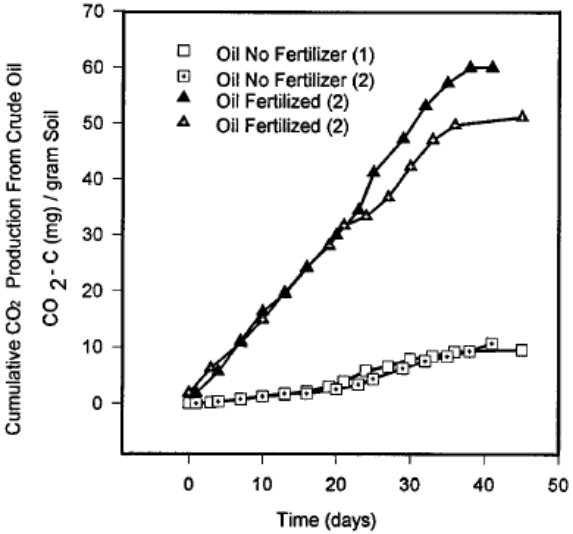
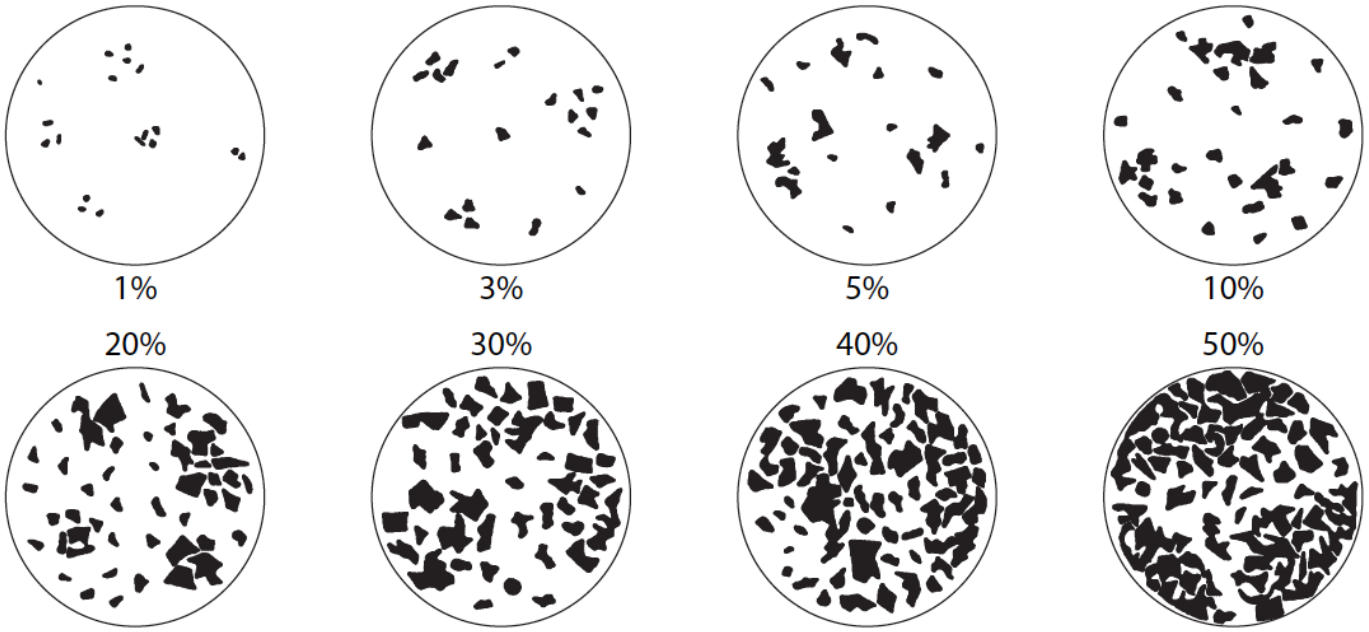


FIGURE 3. Cumulative CO_2-C production (mg/g of soil) from crude oil versus time in aerated microcosms (calculated from isotope dilution equations).


Endpoint?



From NOAA SCAT job aid

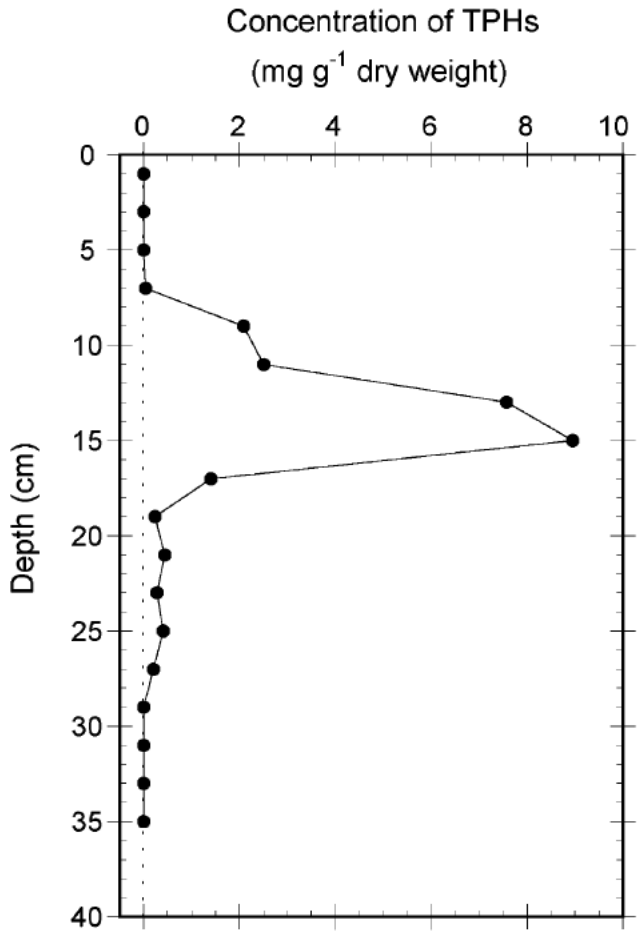


FIGURE 4. Downcore concentration of TPHs at Wild Harbor M-1 core collected in August 2000.

From Reddy et al. 2002

Florida spill, Buzzards Bay, MA 1969

Complex mixture of unresolved petroleum hydrocarbons exist decades after the spill

Questions??