Transport of Crude Oil Aggregates and Associated Microbial Populations: Impact on Biodegradation Potential

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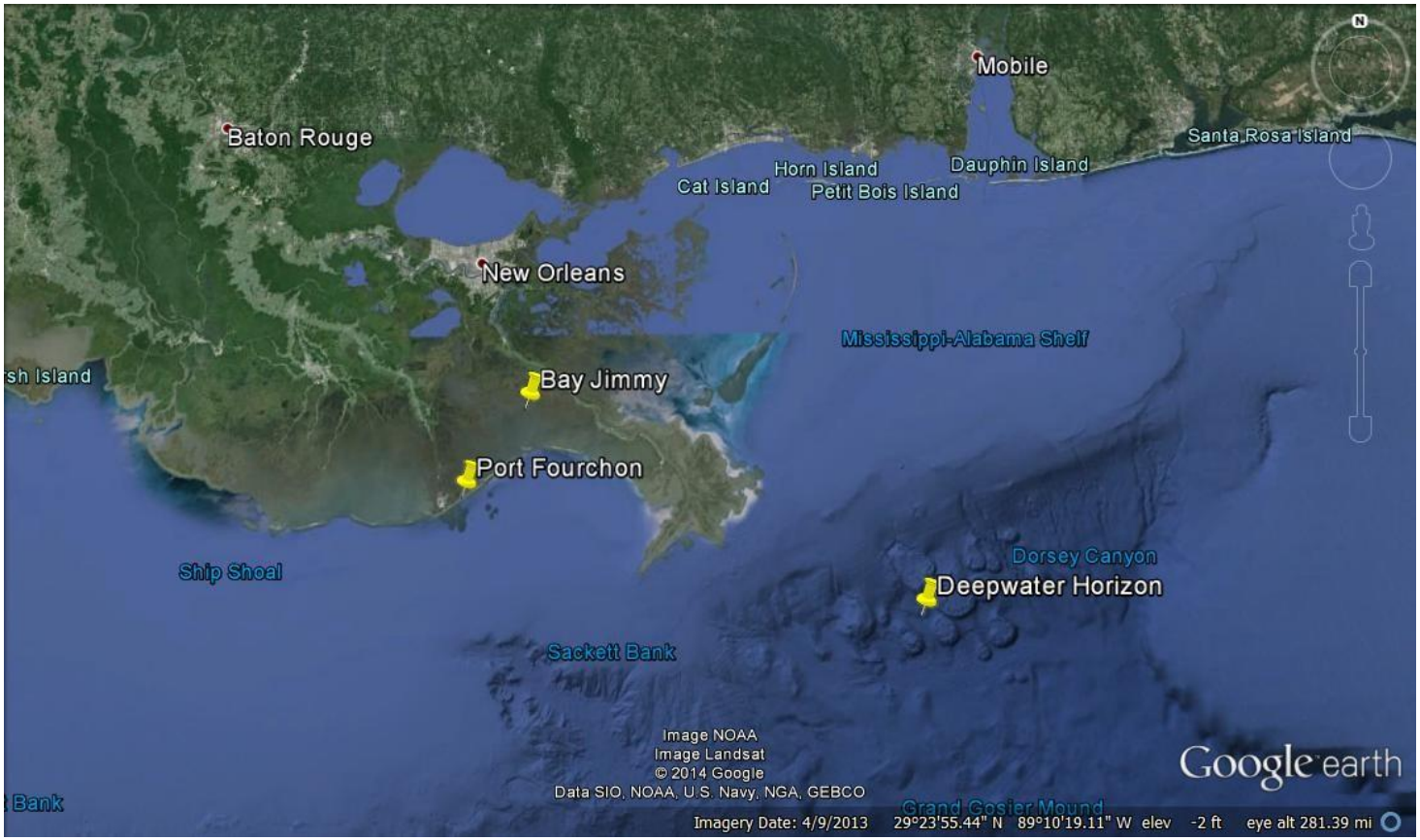
Objectives

- **Extent of weathering in different oil forms; Submerged Oil Mats (SOMs) and Surface Residue Balls (SRBs)**
- **Characterization of Microbial Communities**

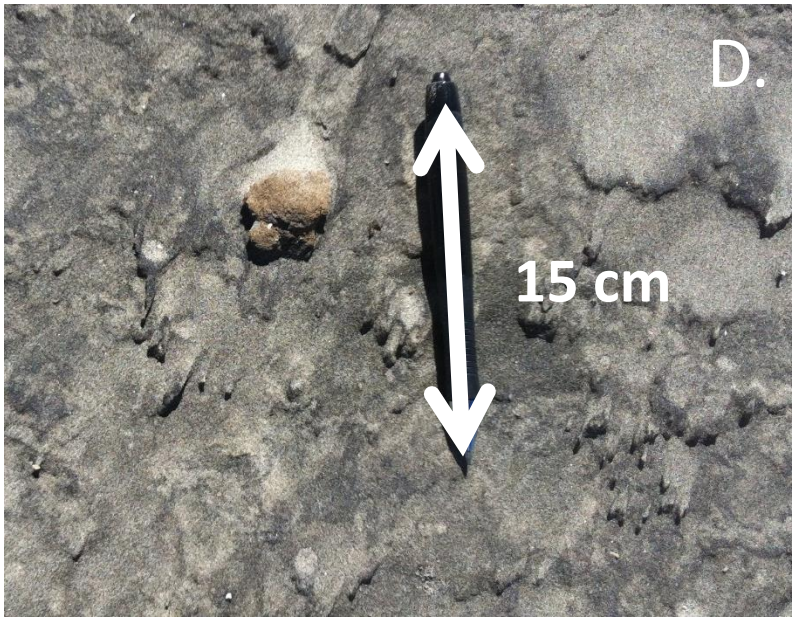
Site Description



SRB/SOM Transport, Port Fourchon, LA

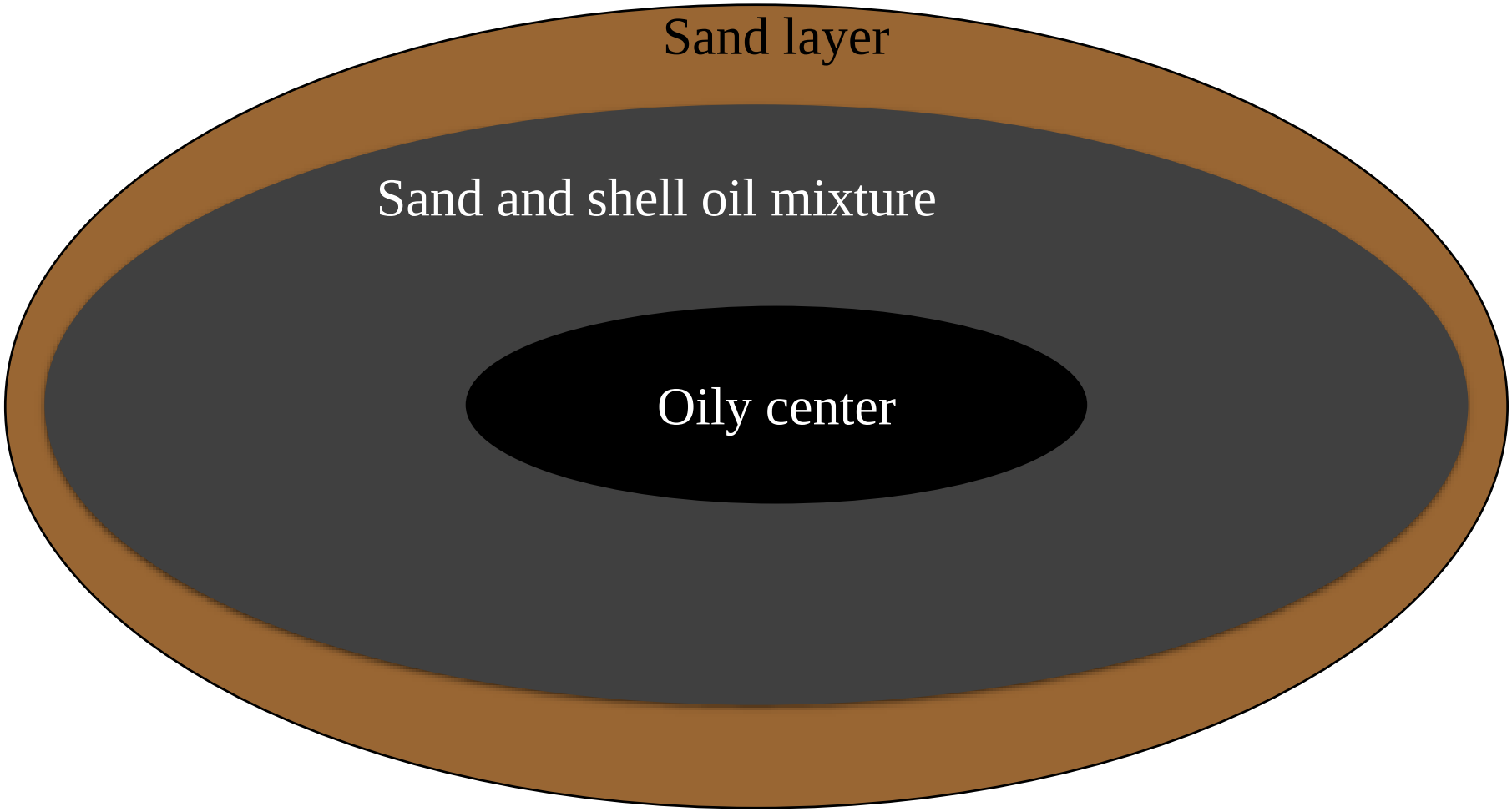
- **Storm-driven conveyor for sand and and oil:sand:shell aggregates and associated microbial populations**
- **Erosion rates > 50 ft/year**

Surface Residue Balls (SRBs)



Submerged Oil Mat (SOM)

SOM/SRB Composition

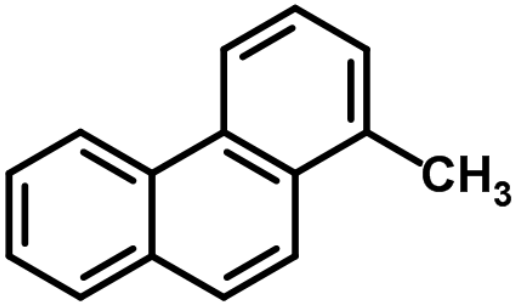


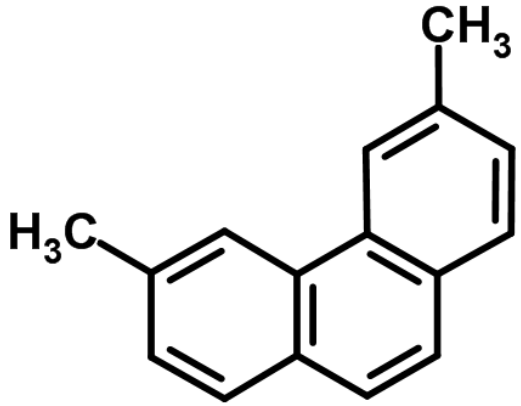
Density (g/cm^3) = 1.32 $\pm$ 0.11, Moisture (%) = 0.16 $\pm$ 0.09

PAHs of Interest

Naphthalenes	Phenanthrenes	Dibenzothiphenes	Chrysenes
C_0-Naphthalene	C_0-Phenanthrenes	C_0-Dibenzothiophenes	C_0-Chrysenes
C_1-Naphthalenes	C_1-Phenanthrenes	C_1-Dibenzothiophenes	C_1-Chrysenes
C_2-Naphthalenes	C_2-Phenanthrenes	C_2-Dibenzothiophenes	C_2-Chrysenes
C_3-Naphthalenes	C_3-Phenanthrenes	C_3-Dibenzothiophenes	C_3-Chrysenes
C_4-Naphthalenes	C_4-Phenanthrenes		

Fluorenes	Others
C_0-Fluorenes	Hopanes
C_1-Fluorenes	Fluoranthene
C_2-Fluorenes	Pyrene
C_3-Fluorenes	Acenaphthylene
	Acenapthene





PAHs: Data Analysis

Weathering Ratio:

- Weathering Ratio Phenanthrenes

$$\frac{(100 * \Sigma PHEN)}{(\Sigma PHEN + \Sigma CHRY)}$$

- Weathering Ratio Dibenzothiophenes

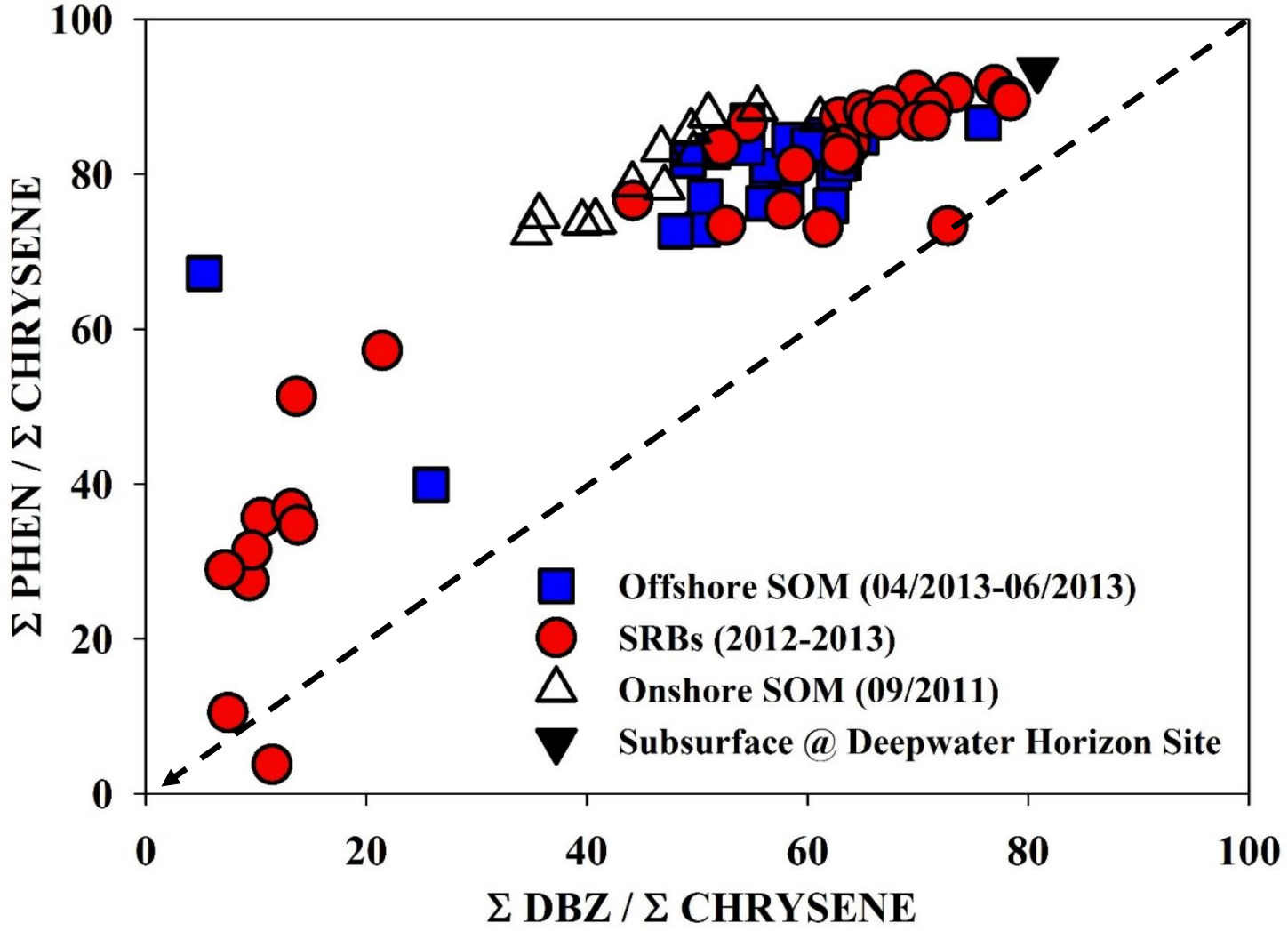
$$\frac{(100 * \Sigma DBZ)}{(\Sigma DBZ + \Sigma CHRY)}$$

Microbial Community Analysis

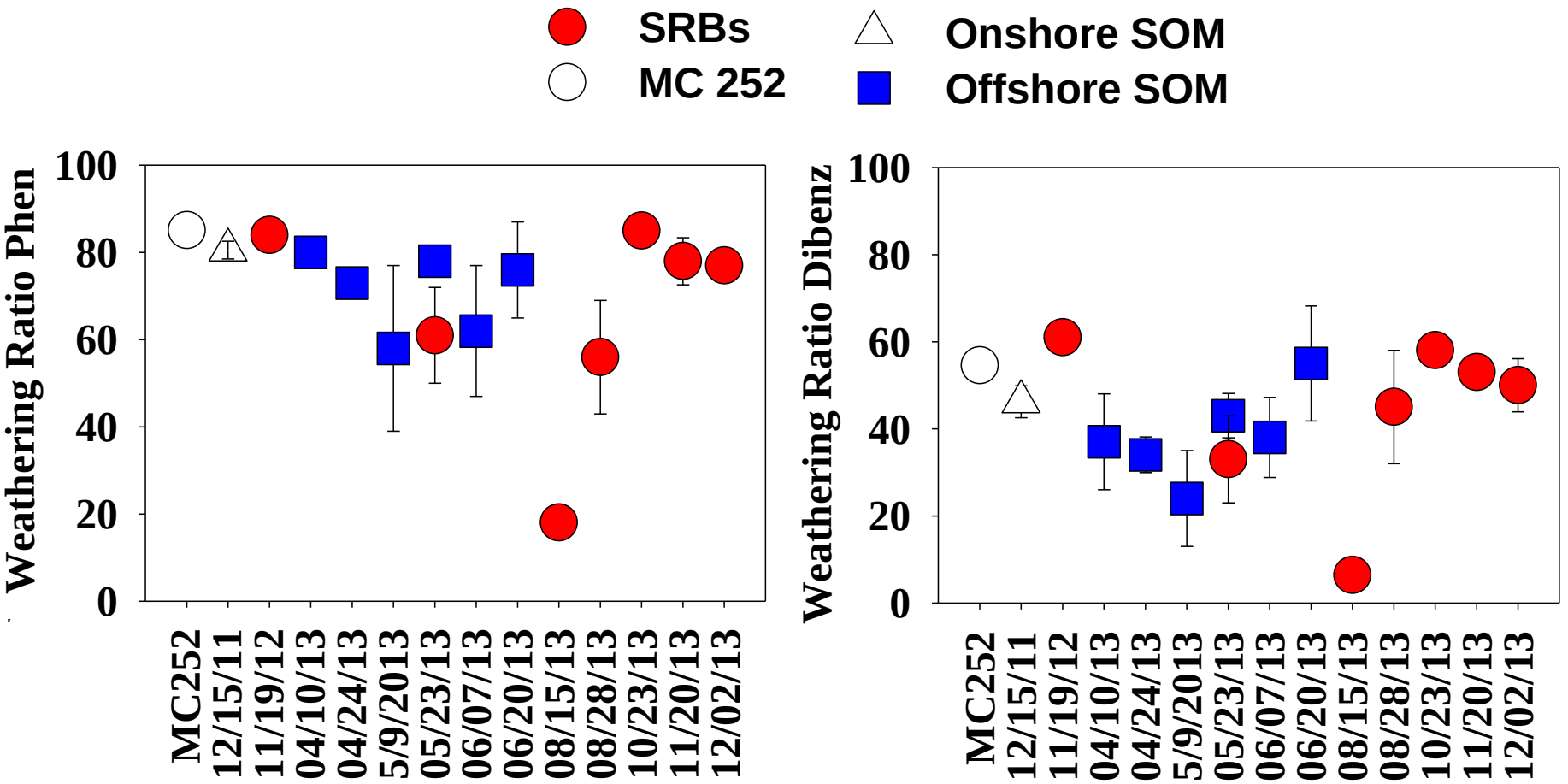
- **Genomic DNA from soil were extracted and 16S rRNA from V4 region was sequenced by Illumina MiSeq platform**

- **Bioinformatics analysis by Mothur program**

Results: SOM and SRBs Weathering



Results: Impacts of Washover Events

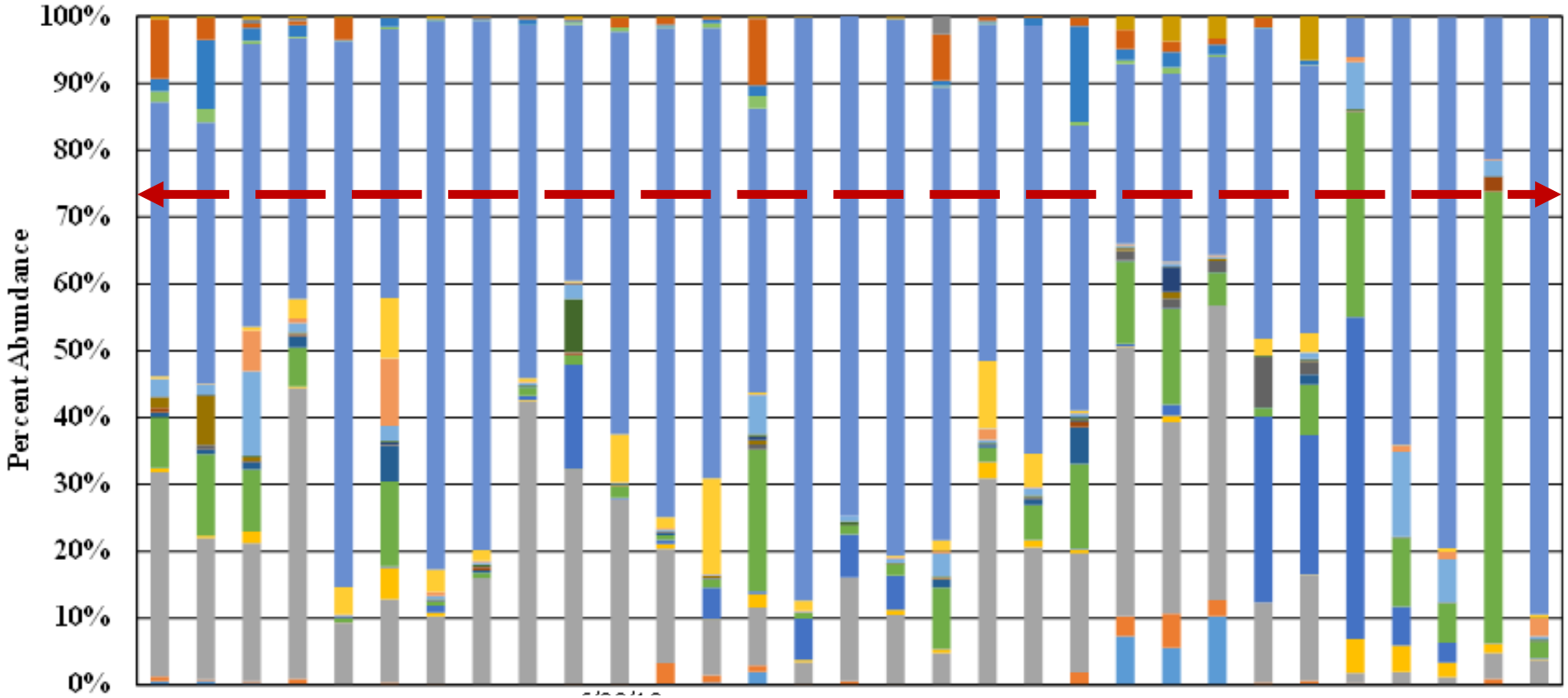


- 12/15/11, Lee
- 11/19/12, Isaac
- 10/23/13, Karen

Results: Impacts of Washover Events- Distribution of PAHs

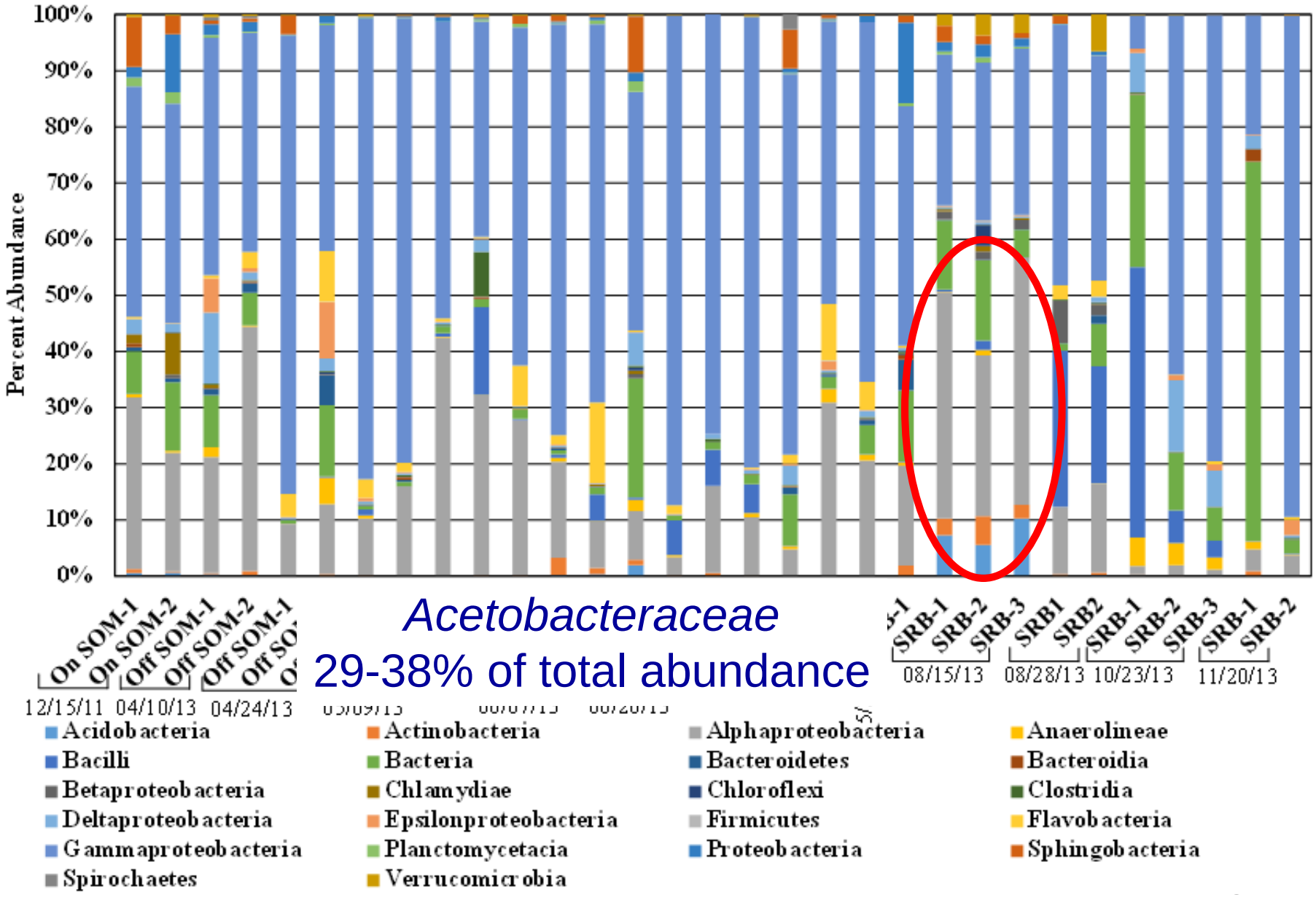
Compounds	Percentage of Total PAH	
	MC 252	Port Fourchon
Naphthalene	8	<1
C_1-Naphthalenes	25	<1
C_2-Naphthalenes	12	<1
C_3-Naphthalenes	12	<1
C_4-Naphthalenes	6	<1
C_1-Phenanthrenes	1	3 to 35
C_2-Phenanthrenes	1	3 to 35
C_3-Phenanthrenes	1	3 to 35
C_4-Phenanthrenes	1	0.3 to 2
C_1-Dibenzothiophenes	1	≤1
C_2-Dibenzothiophenes	1	1 to 13
C_3-Dibenzothiophenes	1	1 to 13
C_1-Chrysenes	1	4 to 25
C_2-Chrysenes	1	4 to 25
C_3-Chrysenes	1	1 to 4

Results: Microbial Community



Alcanivorax, *Altermonas*, *Idiomarina, Halothiobacillus, Halomonas, Marinobacter, Oceanospirillaceae, Porticoccus, Pseudoalteromonas, Singularimonas, Thiomicrospira,* and *Vibrio*

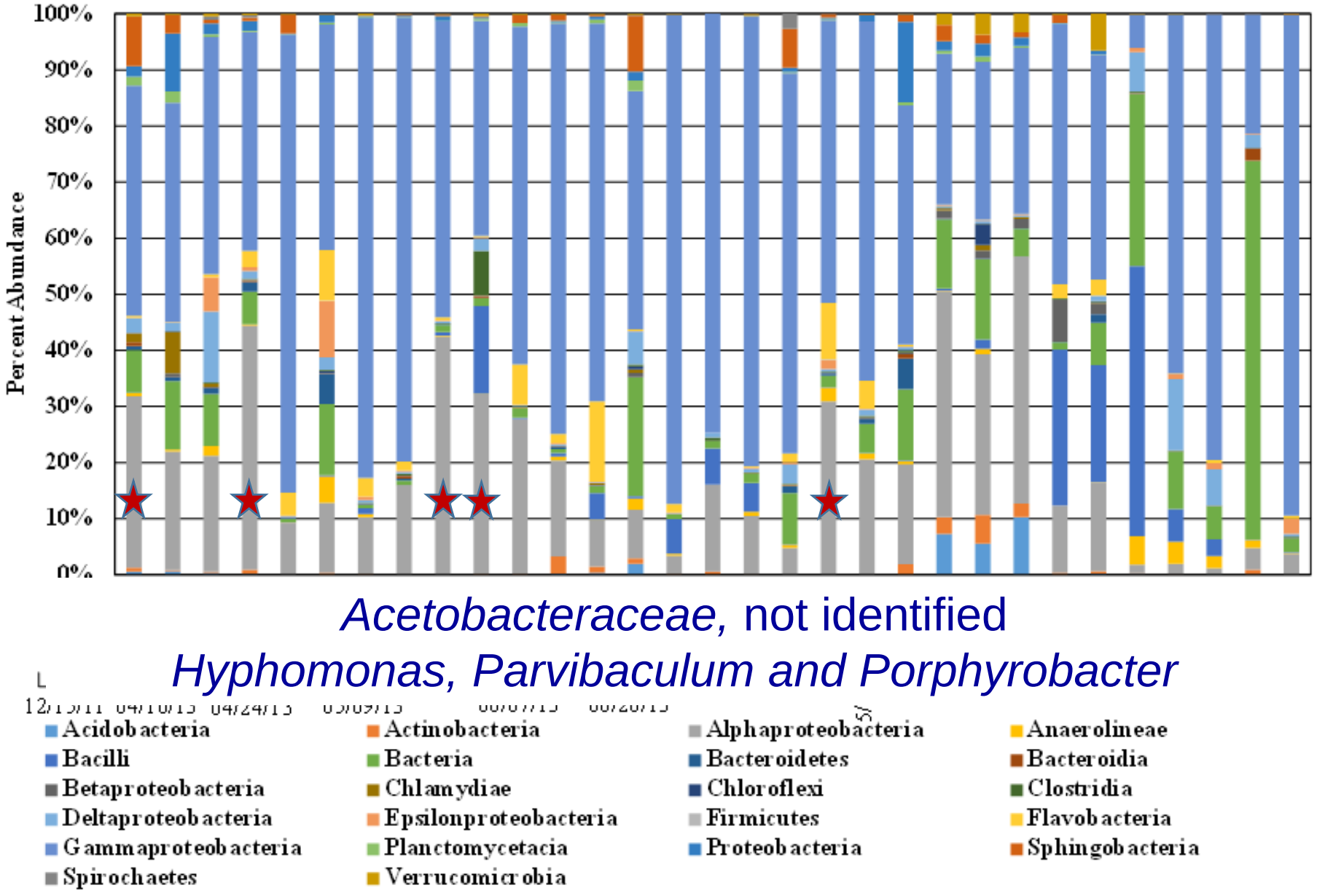
Results: Microbial Community



Acetobacteraceae

29-38% of total abundance

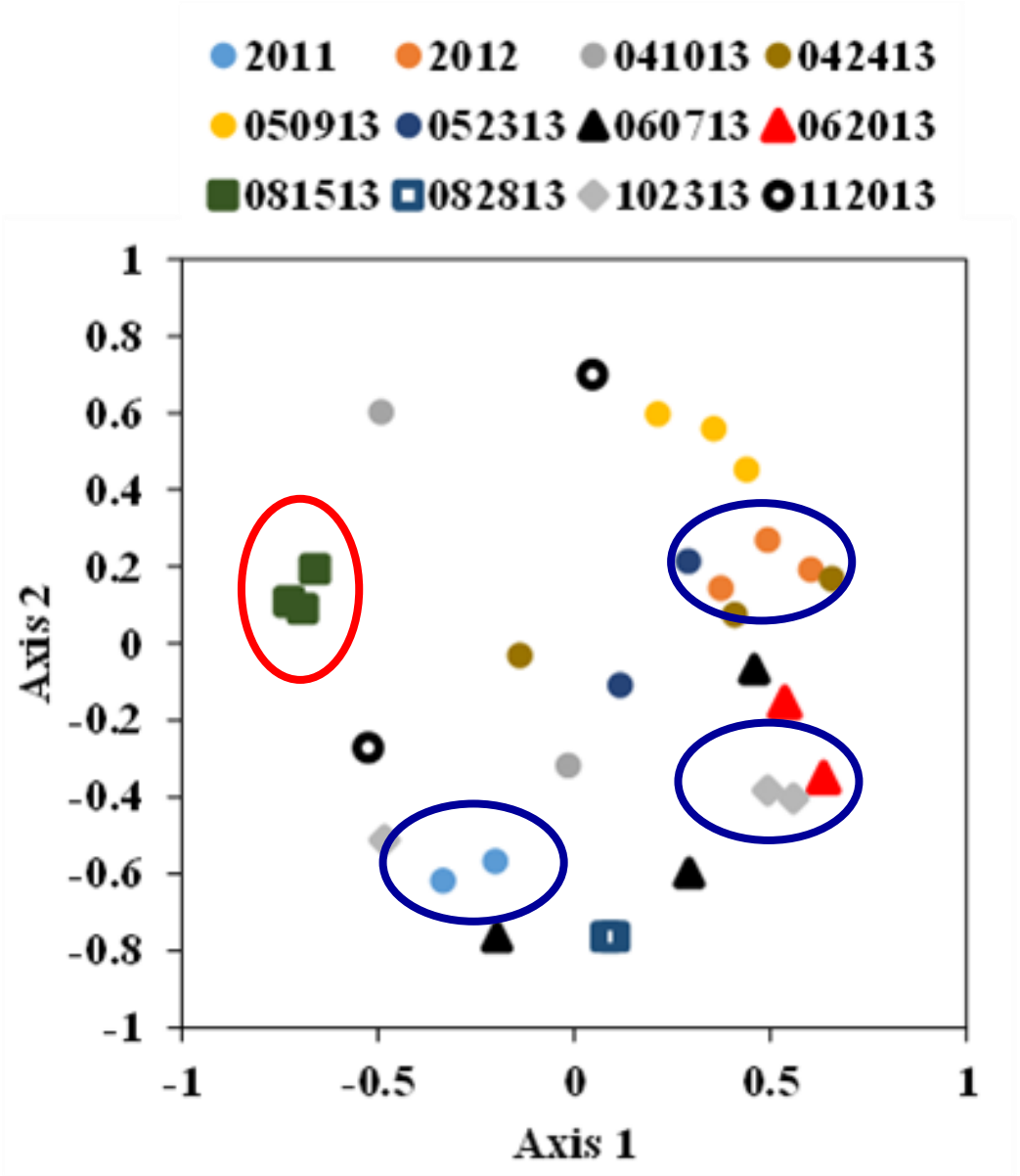
Results: Microbial Community



Acetobacteraceae, not identified

Hyphomonas, Parvibaculum and Porphyrobacter

Results: Non-metric multidimensional Scaling

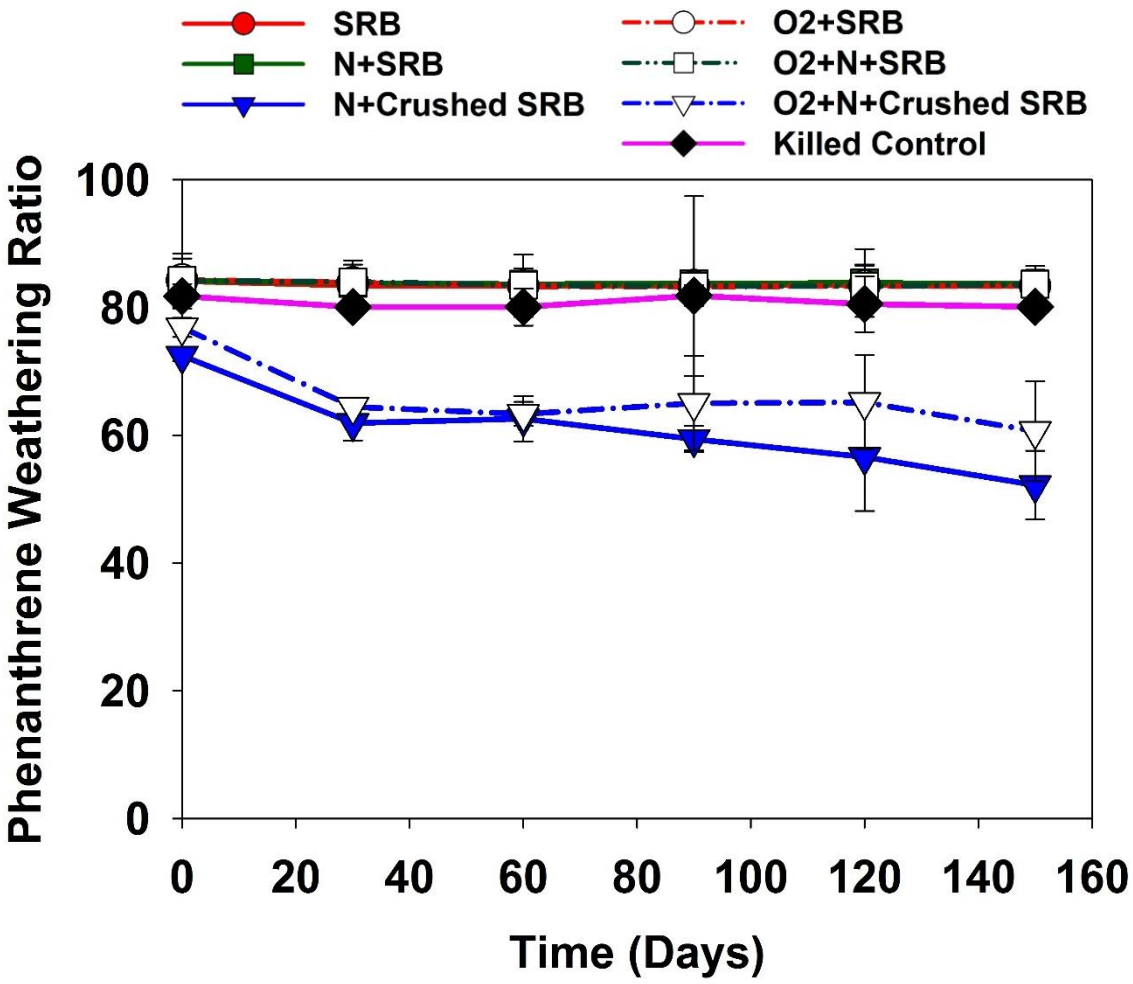


Microcosm Design

Anaerobic	SRB
	SRB + Nitrogen
	Crushed SRB + Nitrogen
Aerobic	SRB + Oxygen
	SRB + Nitrogen + Oxygen
	Crushed SRB + Nitrogen + Oxygen
Killed Control	

Duration: 150 days
Triplicate bottles sacrificed every 30 days

Results: Microcosm



Results: Microcosm Biodegradation Rates

Compound	First order rate (yr^{-1})	
	Crushed Anaerobic	Crushed Aerobic
C1-Phenanthrenes	7.3 ± 4.2	3.2 ± 0.93
C2-Phenanthrenes	8.3 ± 4.8	8.5 ± 3.9
C3-Phenanthrenes	6.6 ± 2.0	7.3 ± 2.6
C4-Phenanthrenes	6.8 ± 2.2	9.4 ± 1.8

Summary

- Alkylated phenanthrenes and dibenzothiophenes poorly weathered in SOMs
- Crushed SRBs are more susceptible to weathering
- Alkylated dibenzothiophenes appears to be preferentially weathered relative to alkylated phenanthrenes
- *Acetobacteraceae* was the dominant phylotype in most weathered SRB
- *Gammaproteobacteria* was the most dominant phylotype

Questions?