# Penetration, accumulation and degradation of Deepwater Horizon oil in Florida sandy beaches

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Thanks to: Mike Santema, Chris Hagan, Chiu Cheng, Lee Russell, Lindsay Chipman, Gina Freyer, Jonathan Delgardio, Dave Oliff

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OCE-1057417
OCE-1044939

# Pensacola Beach, Wednesday, June 23, 2010

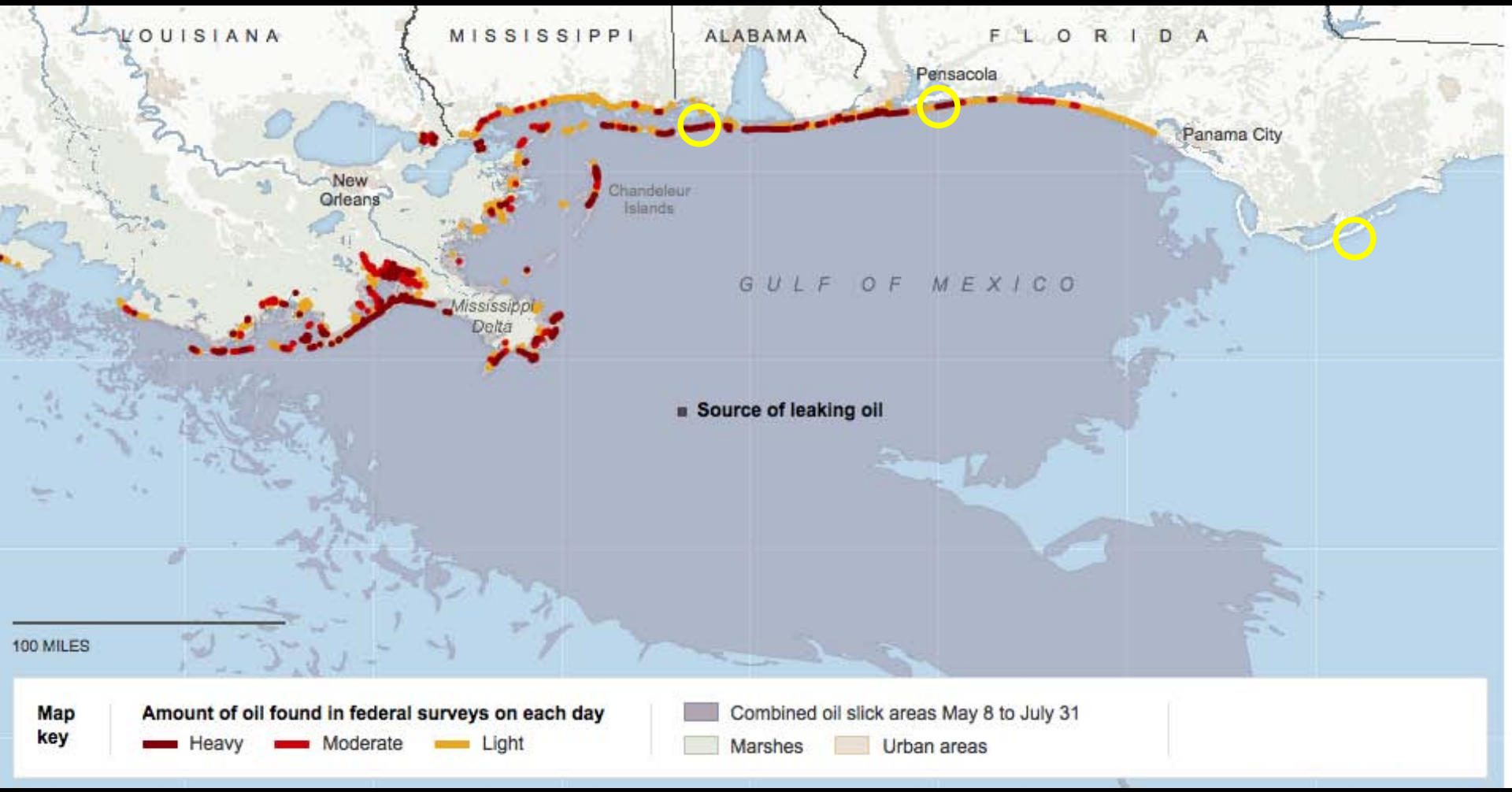
# Objectives

1. Determine distribution of Deepwater Horizon oil in Gulf sandy beaches

2. Assess chemical changes and the fate of the buried oil and whether Vanadium and Nickel can be used as tracer.

3. Characterize oil-degrading microbial groups affecting buried oil.

# Beach contamination



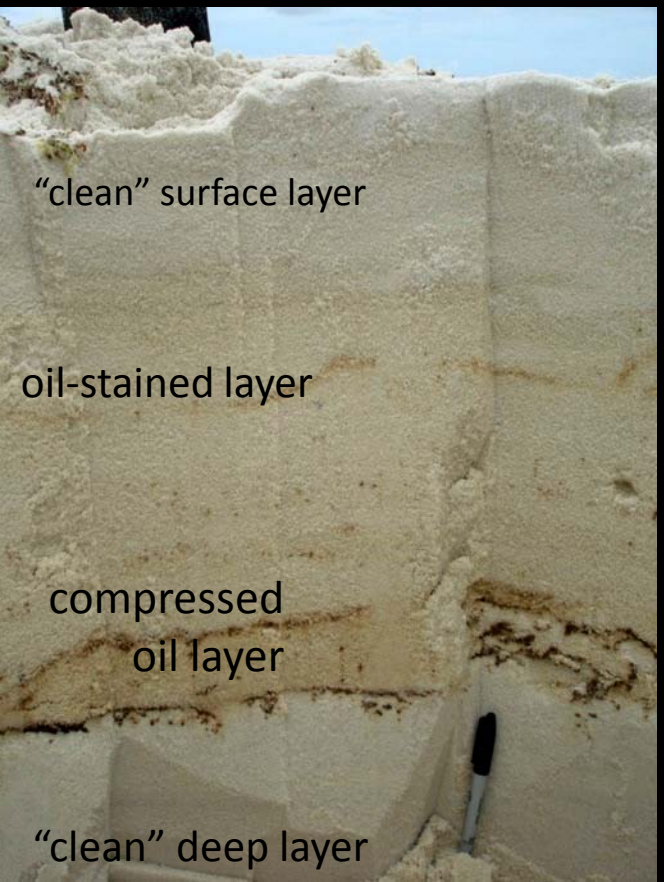

DATA: USGS and NOAA , map published by the New York Times

6/30/2010

Sand was deposited on beached oil layers


Corexit application:
4 050 390 L surface
2 730 000 L sub-surface
(7/12/2010, BP)
Photo: Tyrone Turner/NG

# 7/25/10
# Oil layers at 55 cm



# Isolates of oil degrading-bacteria from beach sands

**Electron Acceptor: $NO_3$**

| # | Isolate | % | Similarity |
|---|---|---|---|
| 1 | EN1 | 100.0% | *Pseudomonas pachastrellae* |
| 2 | EN2 | 99.9% | *Pseudidiomarina maritime* |
| 3 | EN3 | 99.5% | *Marinobacter hydrocarbonoclasticus* |
| 4 | EN4 | 99.1% | *Shewanella algae* |
| 5 | PN-1 | 97.7% | *Vibrio sp. SL-23* |
| 6 | PN-2 | 99.7% | *Pseudomonas stutzeri* |
| 7 | PN-3 | 100.0% | *Alcanivorax dieselolei* |
| 8 | PN-4 | 99.0% | *Vibrio hepatarius* |
| 9 | ES-1 | 99.2% | *Marinobacter vinifirmus* |
| 10 | ES-2 | 99.1% | *Marinobacter vinifirmus* |
| 11 | PBN2/AN | 99.0% | *Bacillus barbaricus* |
| 12 | PBN3/AN | 99.0% | *Halomonas shengliensis* |
| 13 | PBN5/AN | 99.0% | *Vibrio gallicus* |
| 14 | PBN6/AN | 99.0% | *Vibrio alginolyticus* |
| 15 | EVN1/AN | 99.0% | *Marinobacter hydrocarbonoclasticus* |

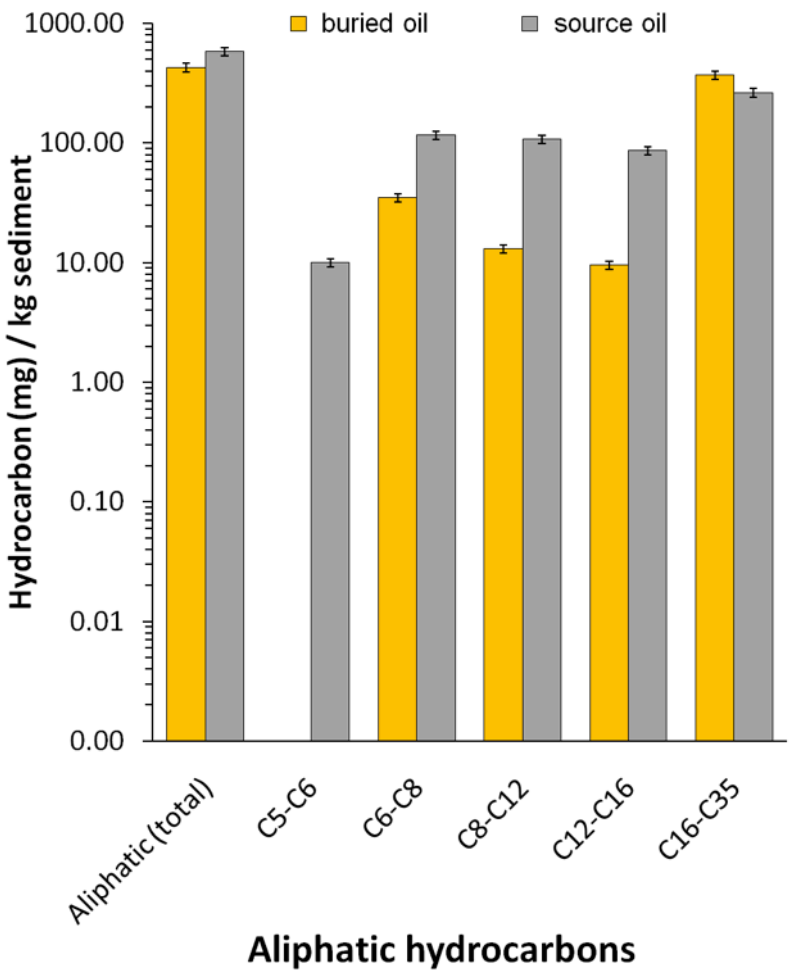
**Electron Acceptor: $O_2$**

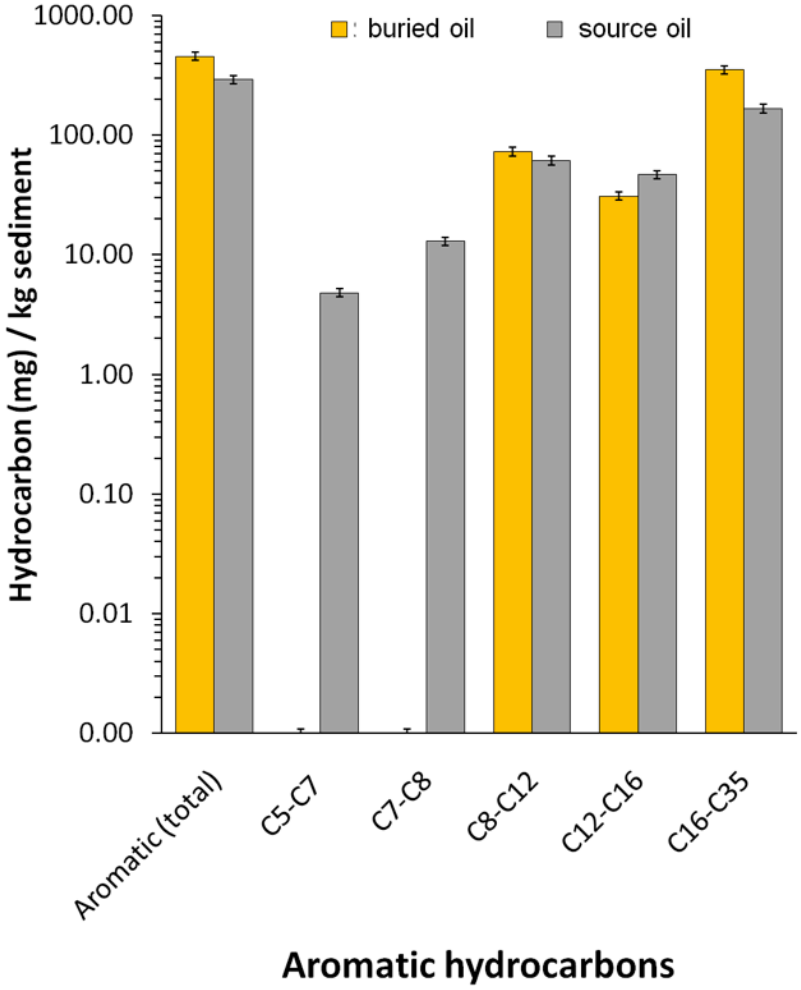
| # | Isolate | % | Similarity |
|---|---|---|---|
| 1 | Cos-1 | 99.0% | *Vibrio sp.* |
| 2 | COS-2 | 100.0% | *Acinetobacter sp.* |
| 3 | COS-3 | 99.0% | *Pseudoalteromonas sp.* |
| 4 | COS-4 | 99.0% | *Acinetobacter sp.* |
| 5 | C1/B10 | 99.0% | *Labrenzia sp.* |
| 6 | P2/S70 | 99.0% | *Alcanivorax sp.* |
| 7 | P2/B30 | 98.0% | *Microbulbifer sp.* |
| 8 | P1 | 98.0% | *Microbacterium sp sp.* |
| 9 | C1/S70 | 99.0% | *Marinobacter hydrocarbonoclasticus* |

24 bacterial strains from 14 genera were isolated from oiled beach sands and confirmed as oil-degrading microorganisms.

*Gammaproteobacteria* (*Alcanivorax*, *Marinobacter*) and *Alphaproteobacteria* (*Rhodobacteraceae*) were key players in beach oil degradation.

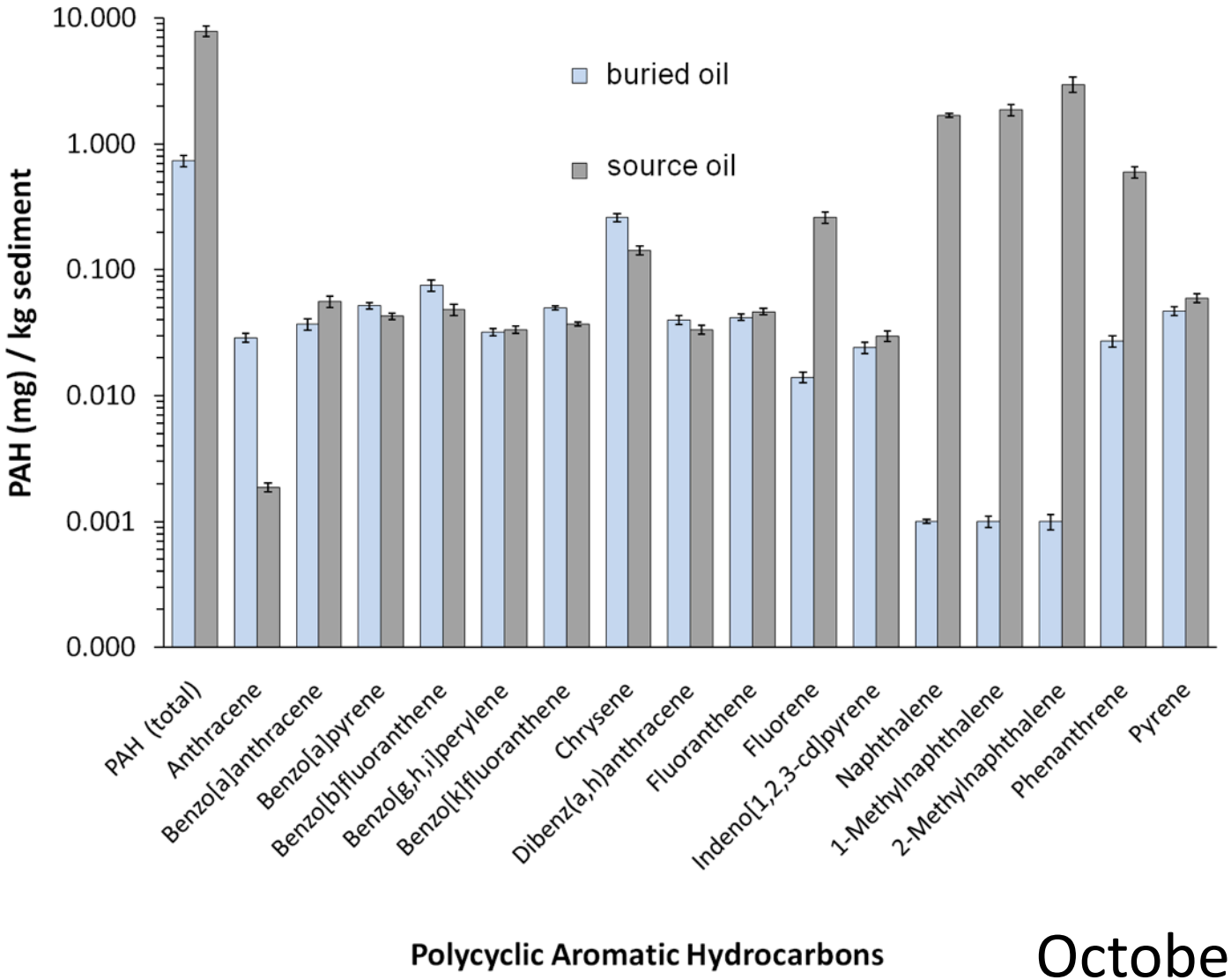
# Losses in aliphatic and aromatic hydrocarbons




October 2010

# Losses in polycyclic aromatic hydrocarbons



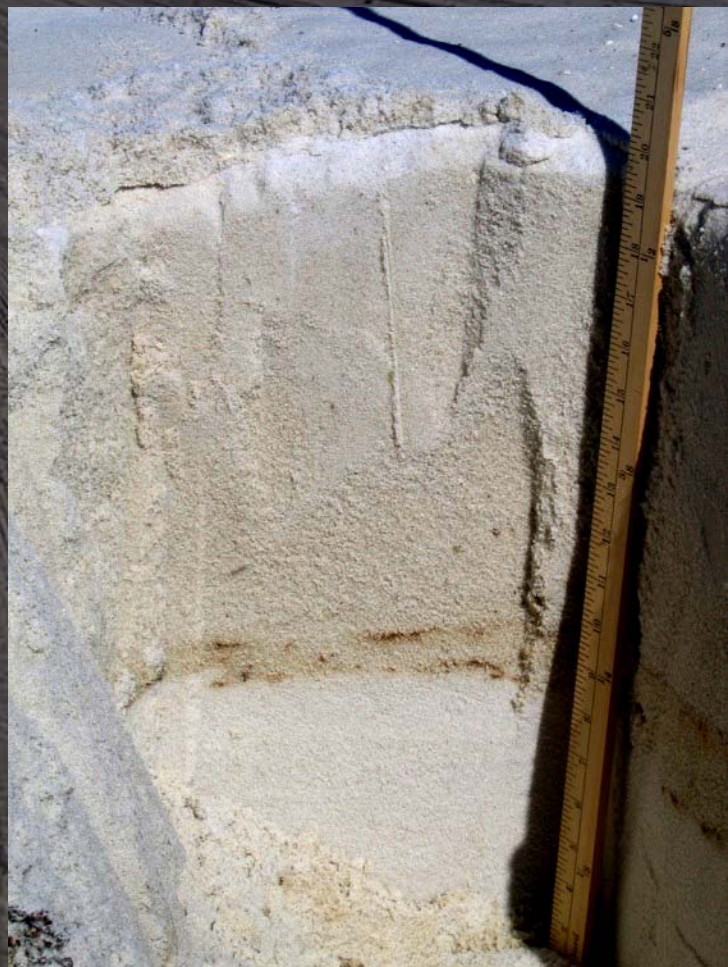

October 2010


10/19/2010
AMES


10/20/2010
DEERE
PUWER
DEERE
Picture: BP

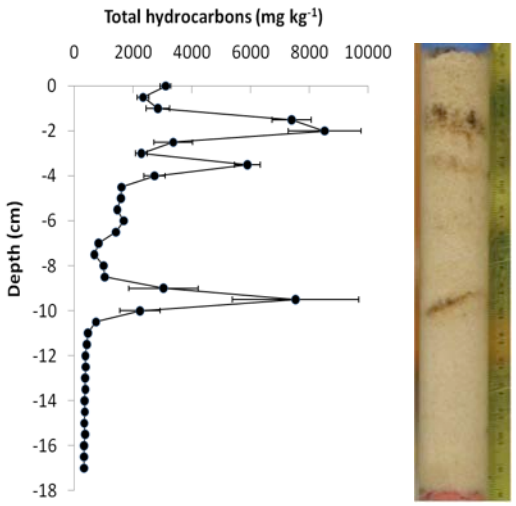

12/02/2010

12/02/2010

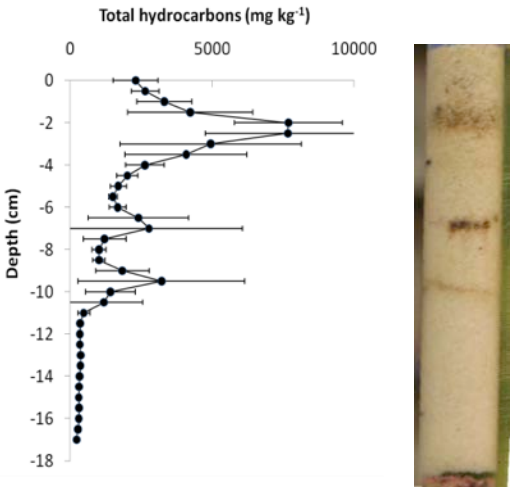


# Hydrocarbon distribution 9/1/10 and 4/21/11

## 2010





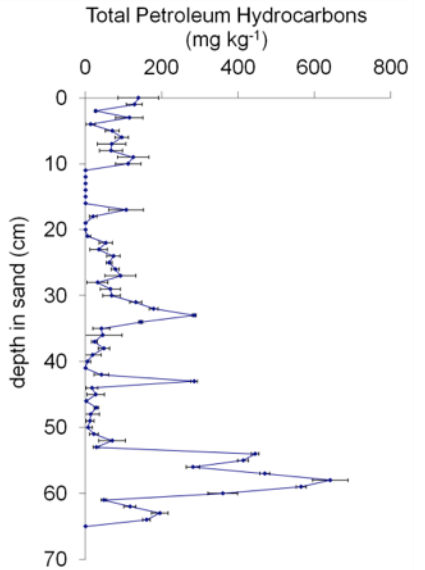



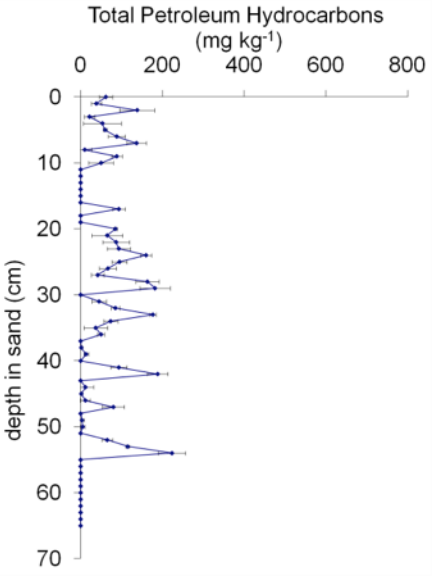



Before deep cleaning, concentrated layers of oil down to 50 - 72 cm depth.

After deep cleaning, dispersed oil, concentration reduced by one order of magnitude

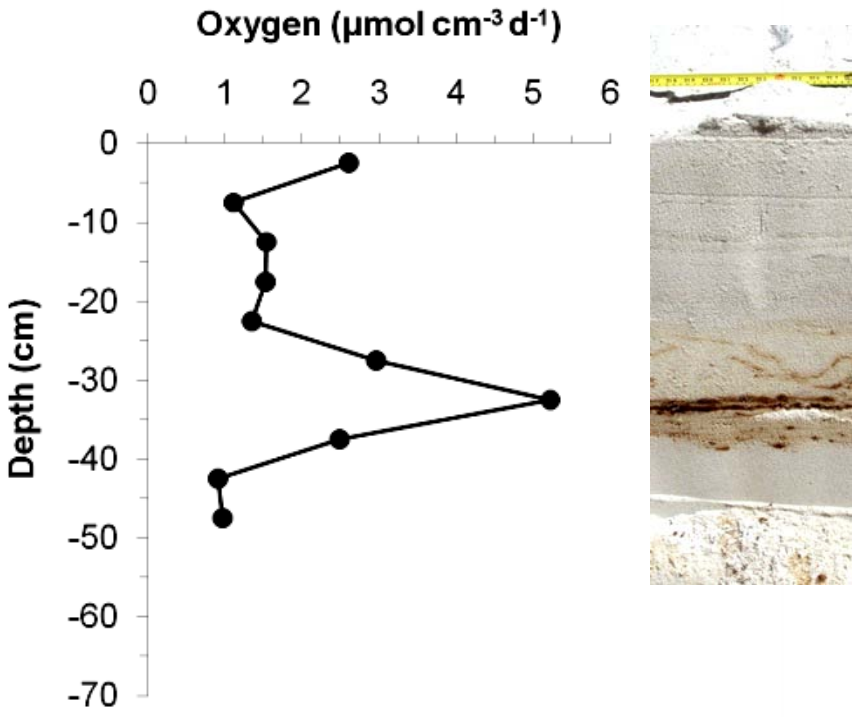
## 2011




# Oxygen consumption rates

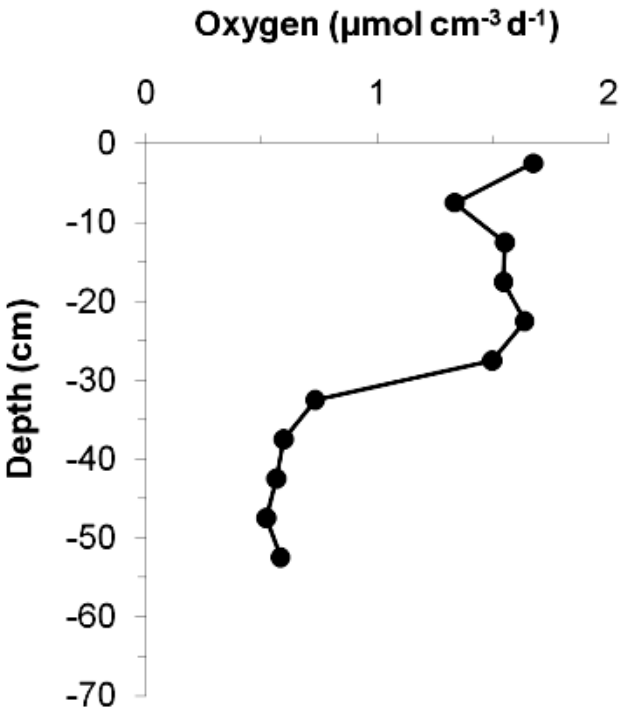
7/30/2010





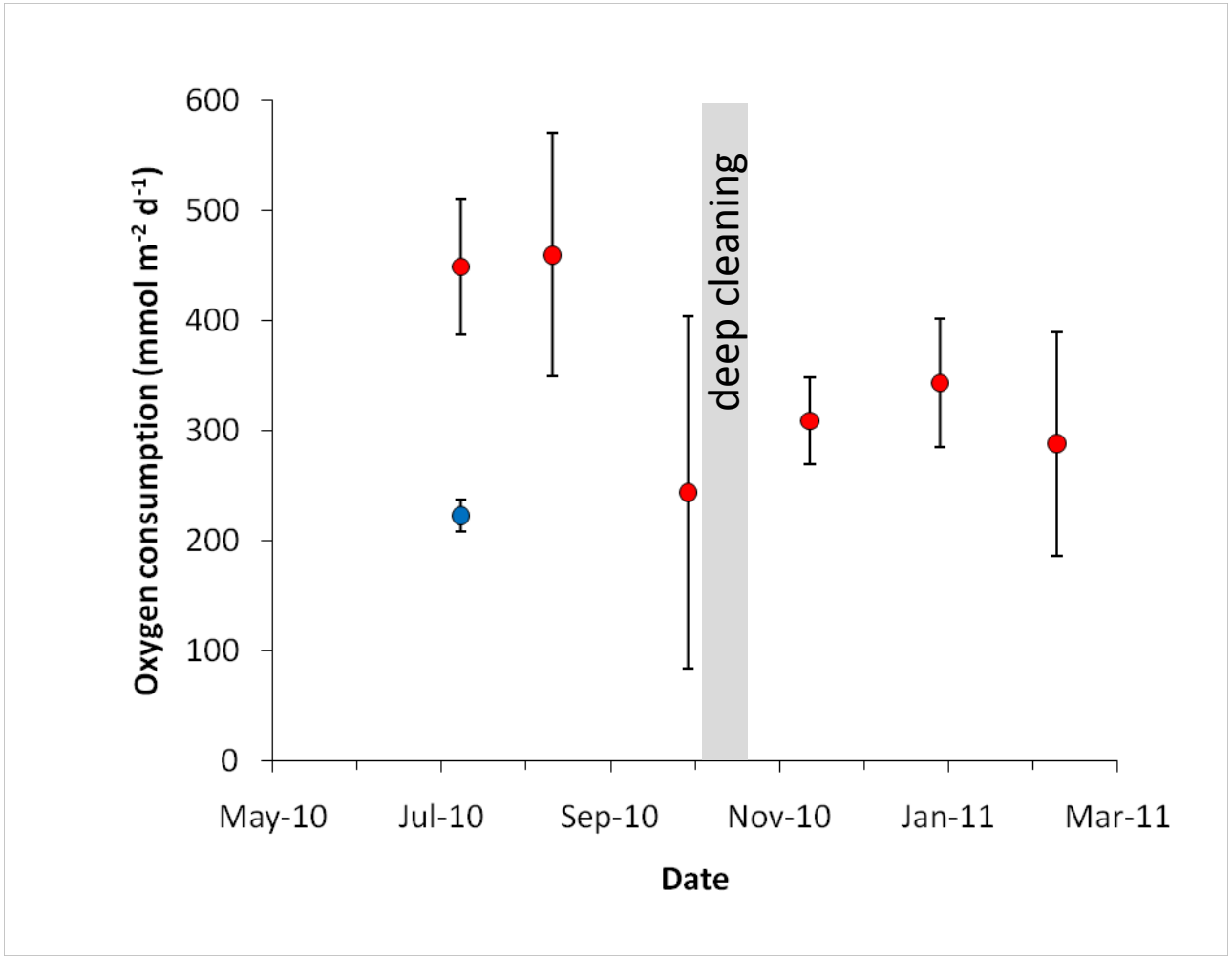

before deep cleaning

12/3/2010




after deep cleaning

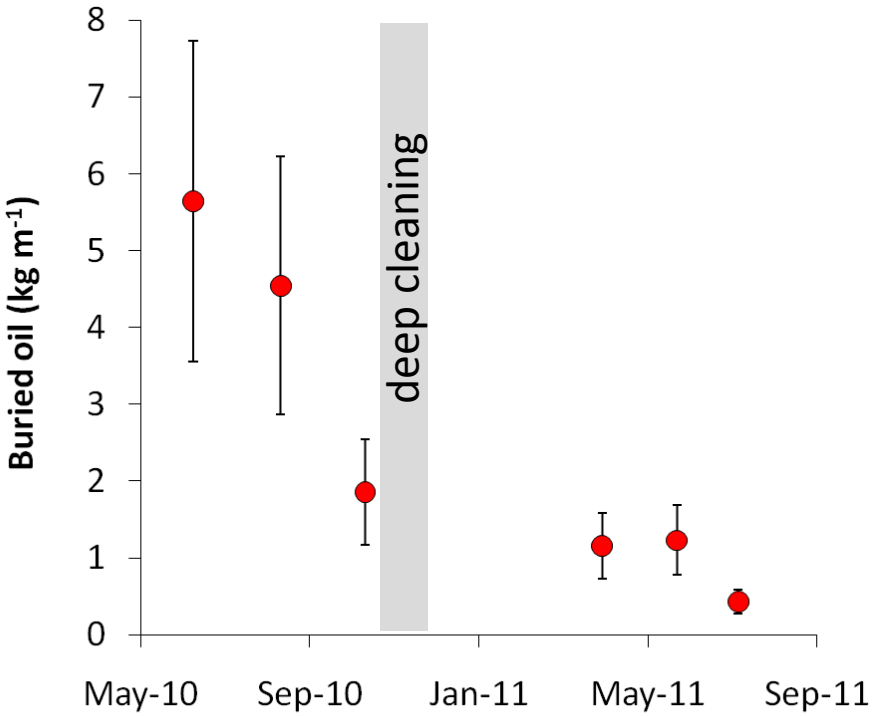
# Potential beach oxygen consumption




Before the deep cleaning, the oxygen consumption had dropped by approx. factor 2

# Estimates on oil in NEGOM sandy beaches

Oil decomposition rate: ~5 g $m^{-2}$ $d^{-1}$
For C10 aliphatic hydroc: ~33 mmol $m^{-2}$ $d^{-1}$
For 82 period Jul-Oct: ~3 mol $m^{-2}$
$O_2$ flux 82 period Jul-Oct: ~ 9 mol $m^{-2}$
Buried oil left: ~7% of initial




Oil degradation used about 1/3 of the beach oxygen consumption
All highly degradable buried oil components could be decomposed within 4 months

# Summary

- Concentrated oil layers were embedded down to 65 cm in Pensacola beach sands. Dispersed oil was transported down to 35 cm.
- Weathering removed C5-C8 and led to a 5-fold increase in O:C ratio reflecting a high degree of oxidative degradation.
- 24 bacterial strains from 14 genera were isolated from the oiled layers and confirmed as oil-degrading microorganisms
- Vanadium and Nickel were significantly increased in the sand layers that contained oil.
- Beach oxygen consumption approximately doubled due to the oil.


Thanks!