

# Can Injuries to the Water Column by the *Deepwater Horizon* Spill Be Resolved from Zooplankton Community Analysis?

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# The Old Paradigm



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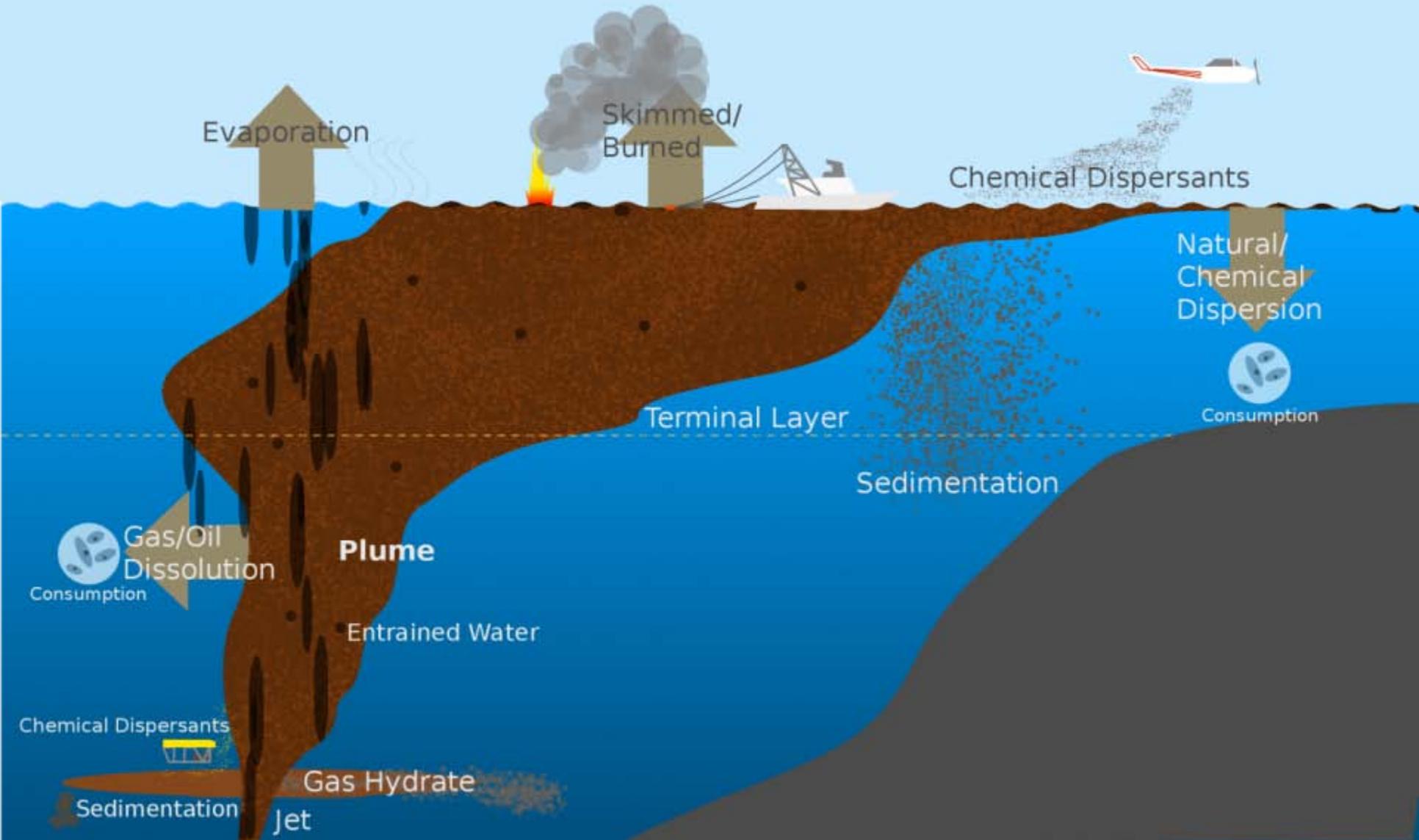
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# The New Paradigm

# Deepwater Horizon: A Tale of Two Spills



# Deepwater Horizon: A Tale of Two Spills

Evaporation

Skimmed/  
Burned

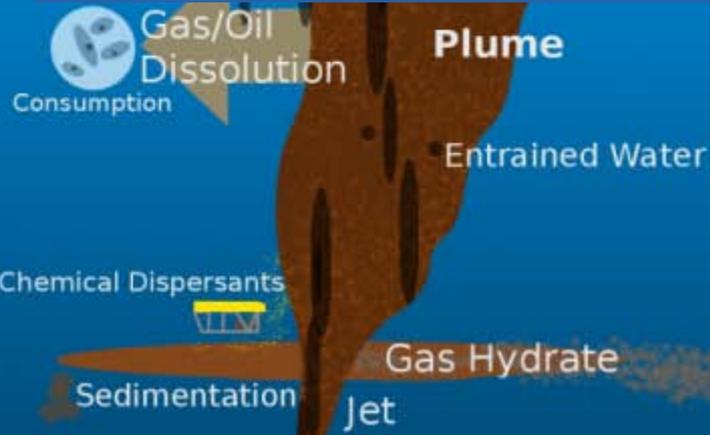
Chemical Dispersants

Natural/  
Chemical

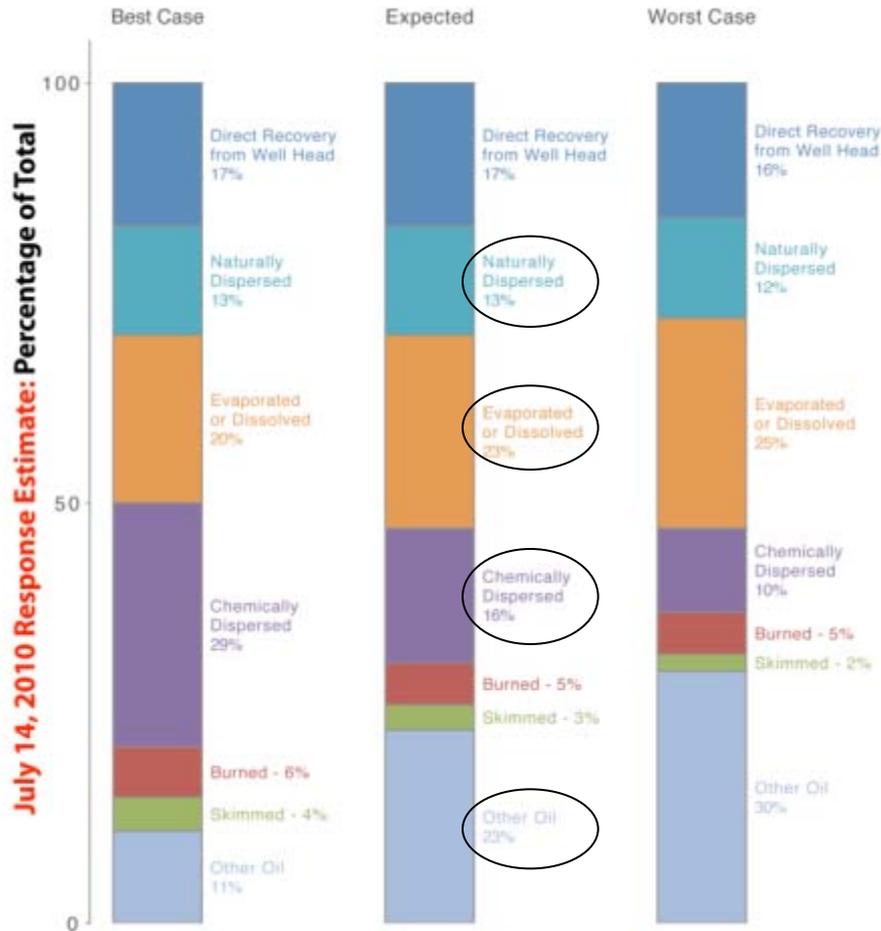
Surface spill of known (limited) volume over relatively short duration

VERSUS

Deep release of unknown, large volume over extended duration



# Petroleum Available for Consumption



4.9 x 10<sup>6</sup> barrels

# Objectives

- Pre-spill zooplankton multi-scale dynamics
  - Sub-seasonal, seasonal, inter-annual
- Natural perturbations within these signals
  - Tropical storms, winter cold-air outbreaks, river variability
- Temporal (and spatial) signal associated with arrival of petroleum hydrocarbons
  - Composition vs. historical
  - Abundance vs. historical

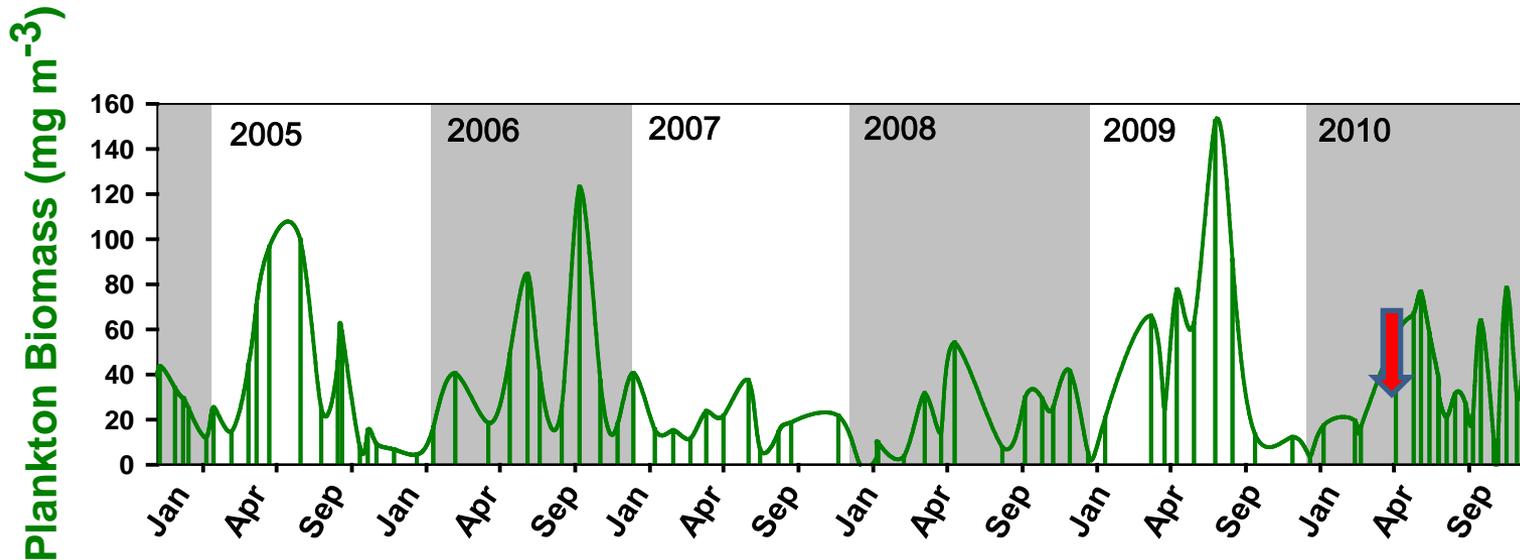
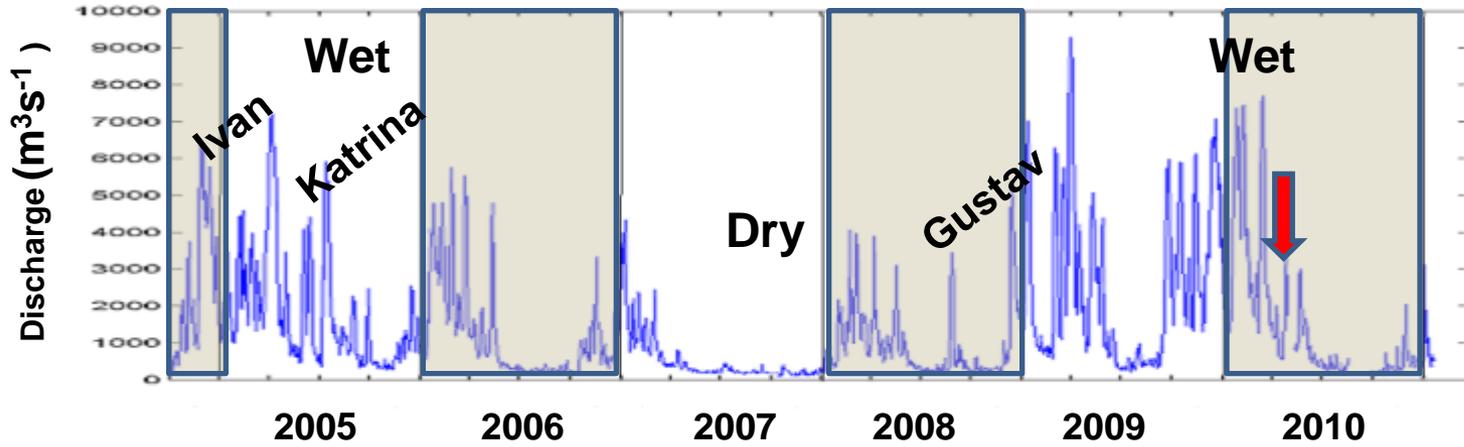
# Approach

- Six-year time-series (FOCAL) [2004 - ]
  - Point and cross-shelf
  - Stratified zooplankton and ichthyoplankton
  - Physical and meteorological record

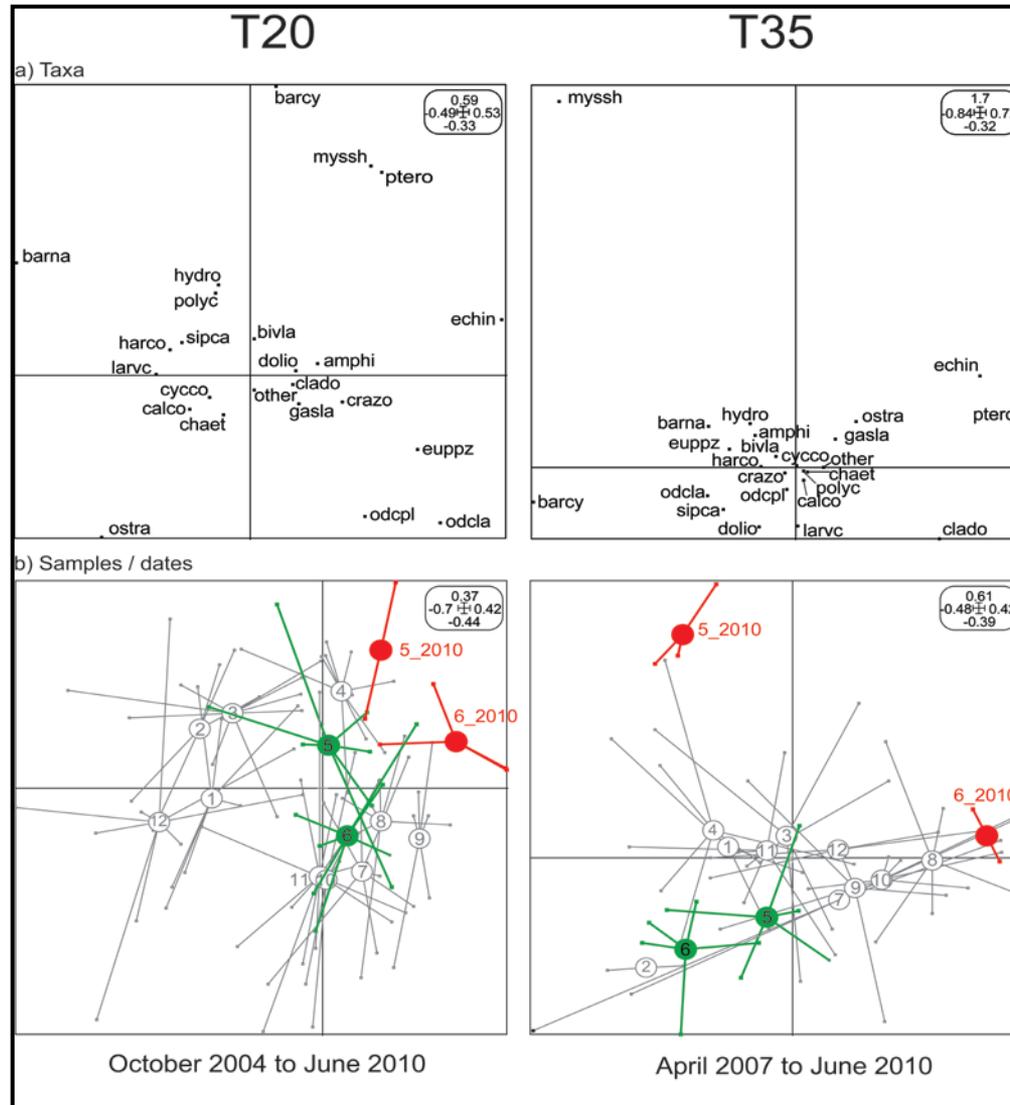


FOCAL sampling stations

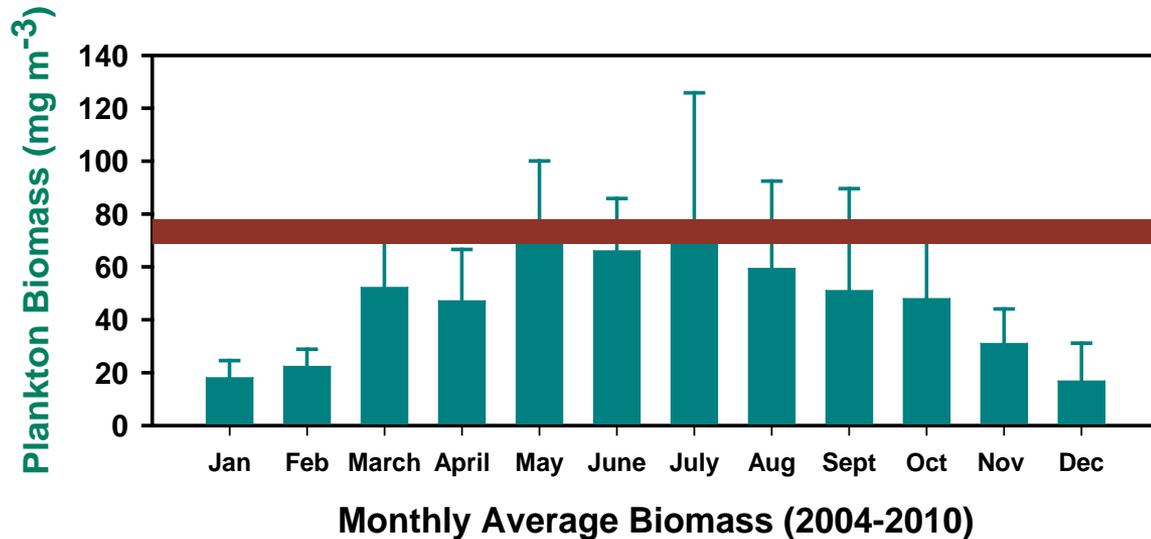
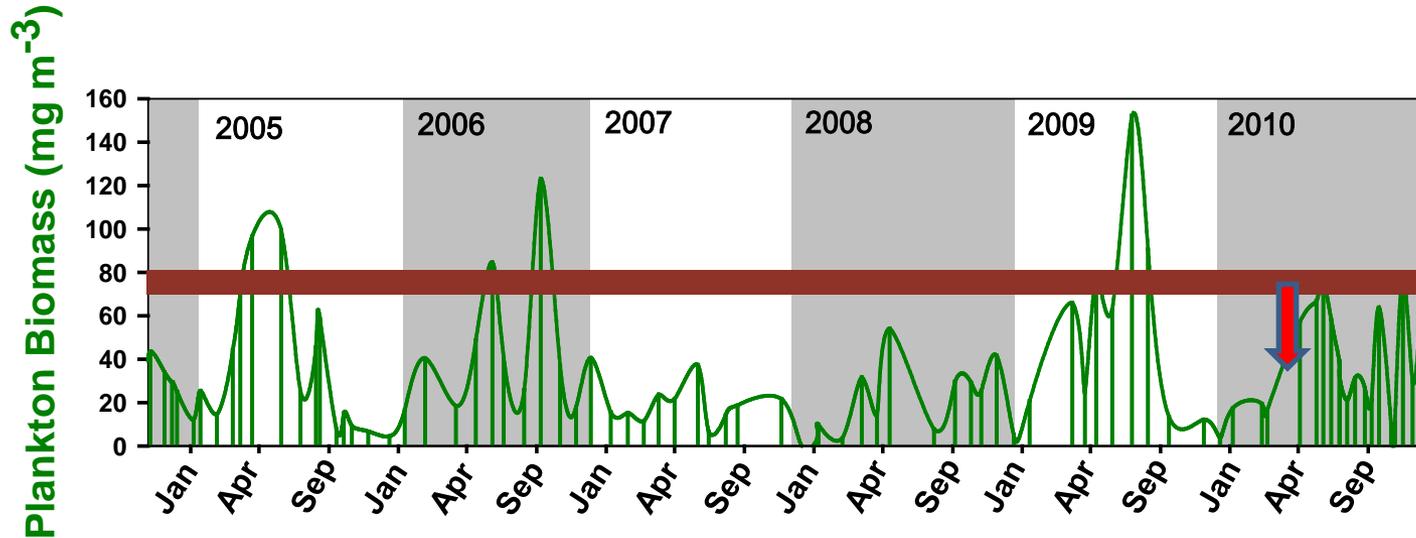
# Variability and Perturbation



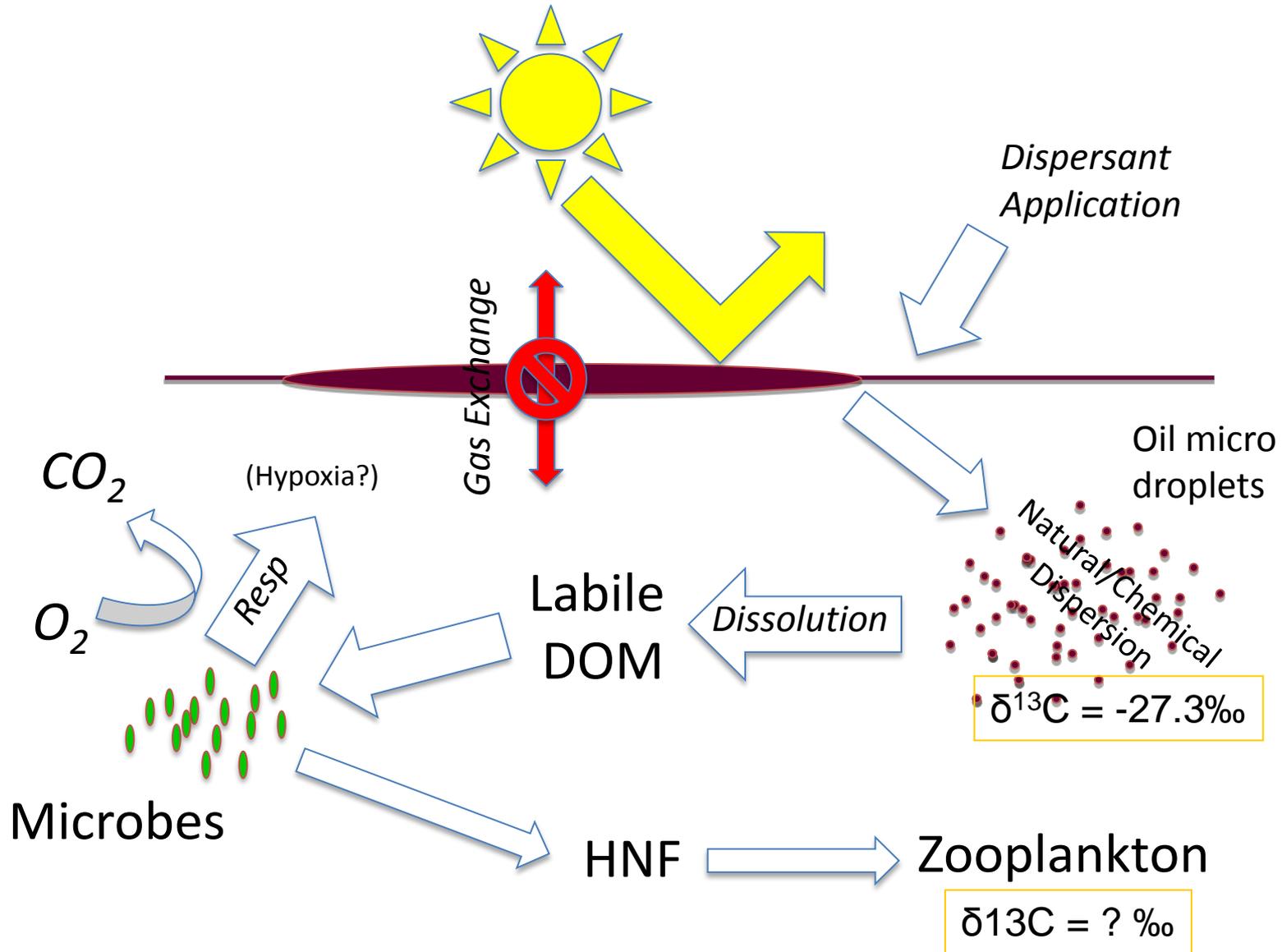
# Correspondence Analysis Zooplankton Community Structure

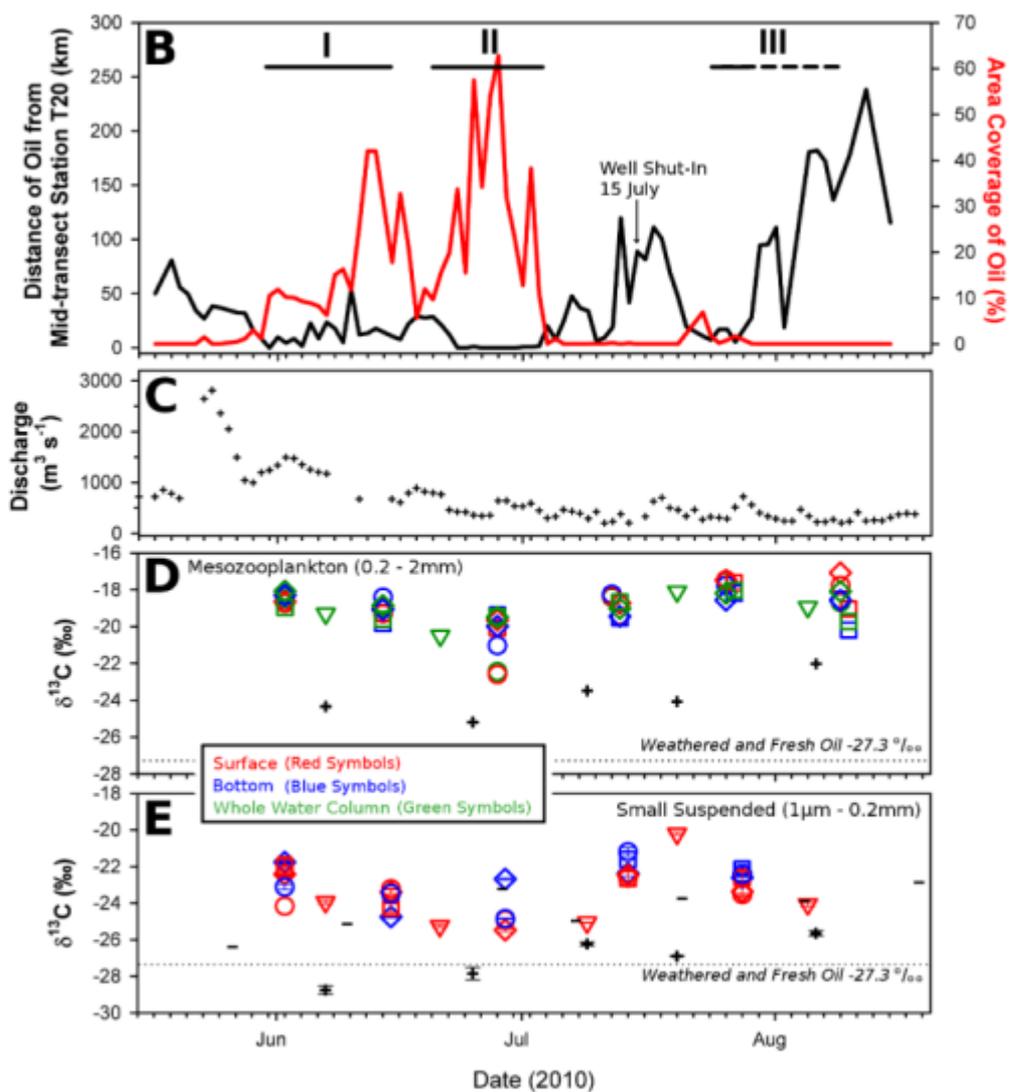
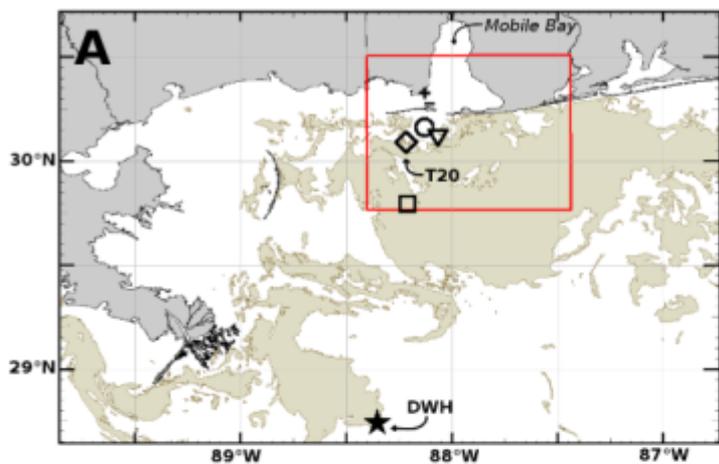


# Did oil carbon supplement zooplankton production?



# Is oil carbon traceable into larger zooplankton fractions?



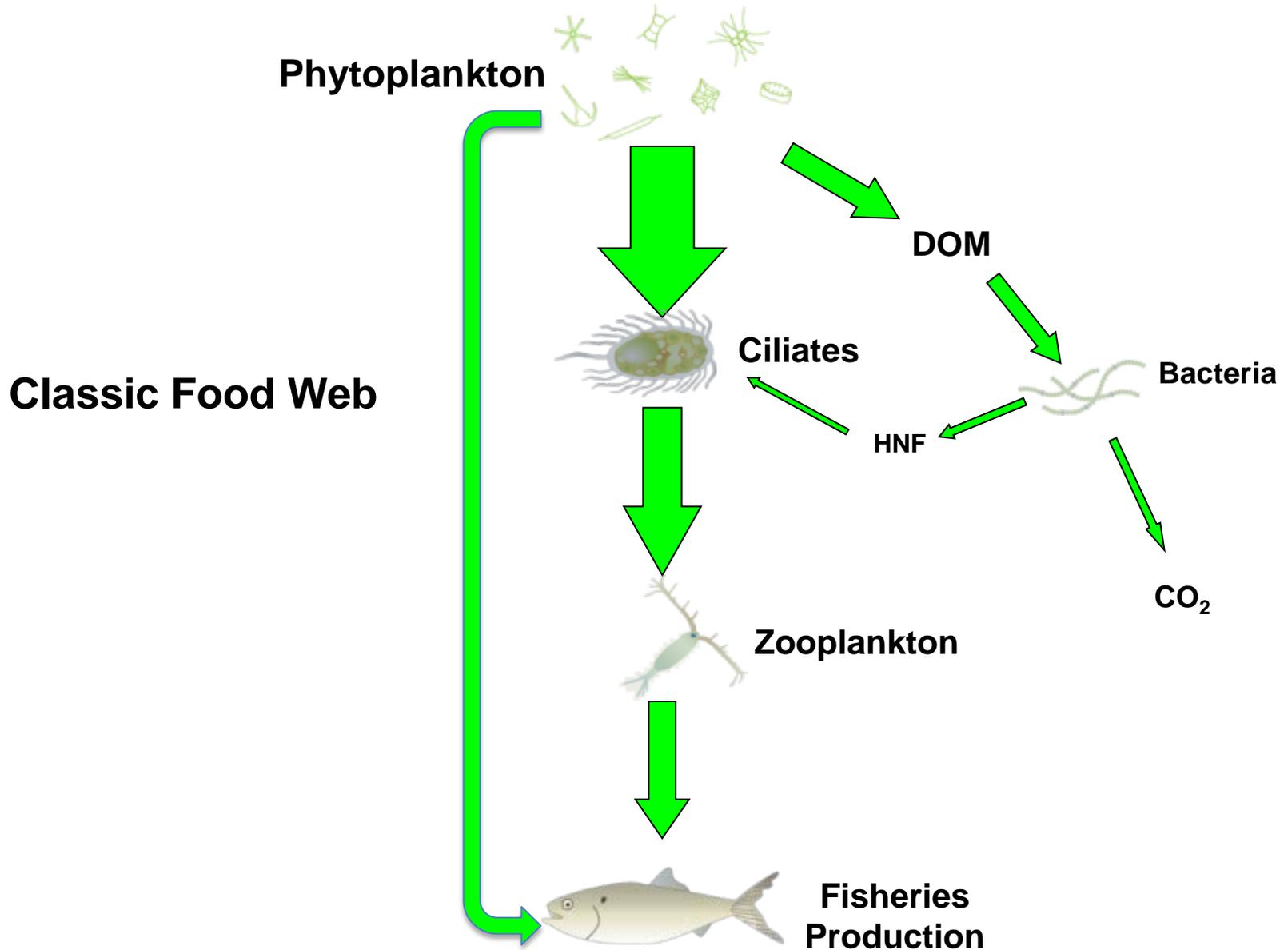


Graham et al. (2010) Env. Res. Letter

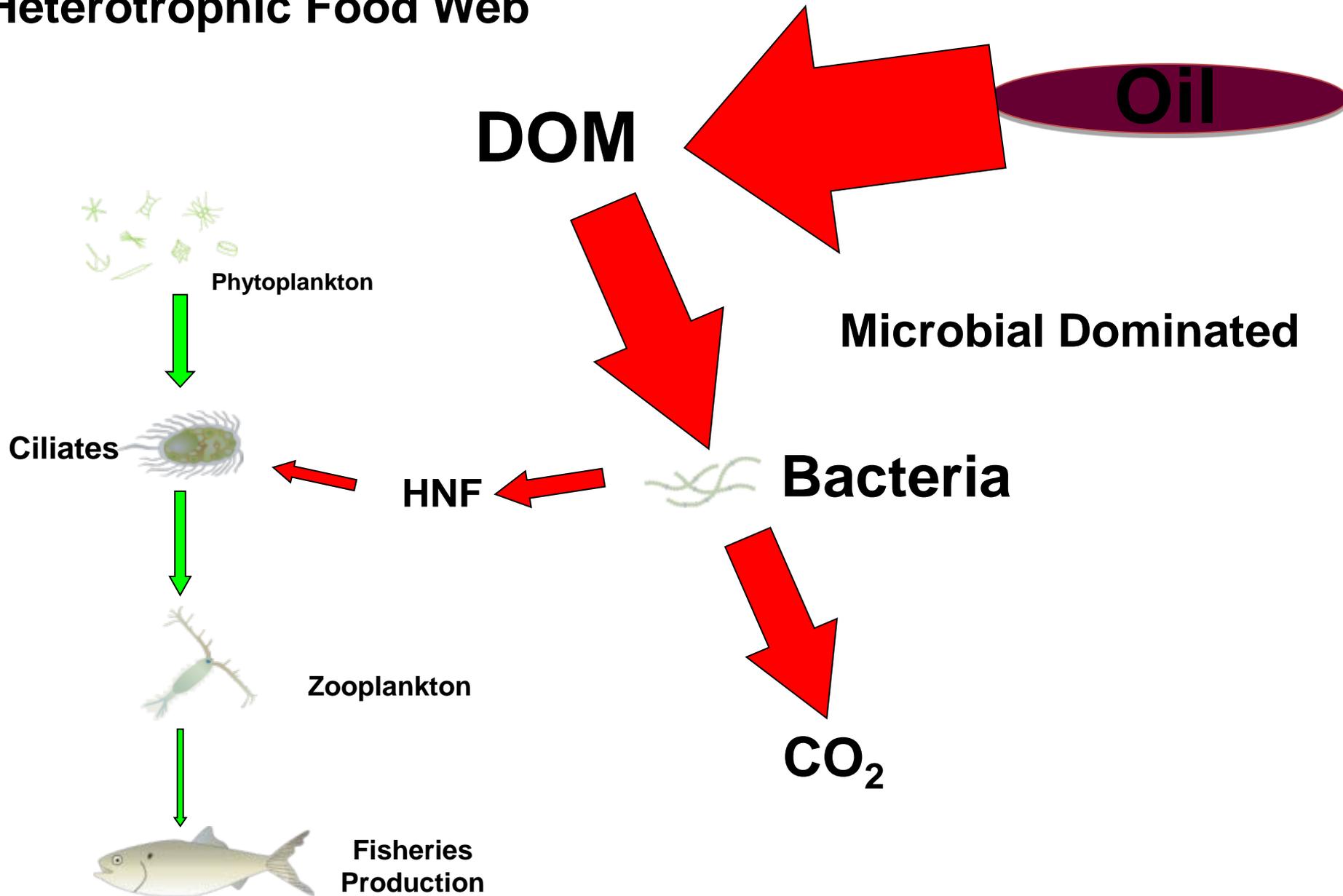
# Carbon Loadings

- 389,519 m<sup>3</sup> petroleum available
- SLC (37.2° API ) (85% C) ~60 M C
- 23.1 x 10<sup>9</sup> mole carbon available
- Compare to published ranges of 1<sup>o</sup> production, ~1 day – 3 months equivalent carbon (planktonic energy)
  - Areal Coverage of Oil ( 10,000 to 200,000 km<sup>2</sup>)
  - Location (open versus coastal ocean)
  - Fractional losses
  - Time/depth partitioned

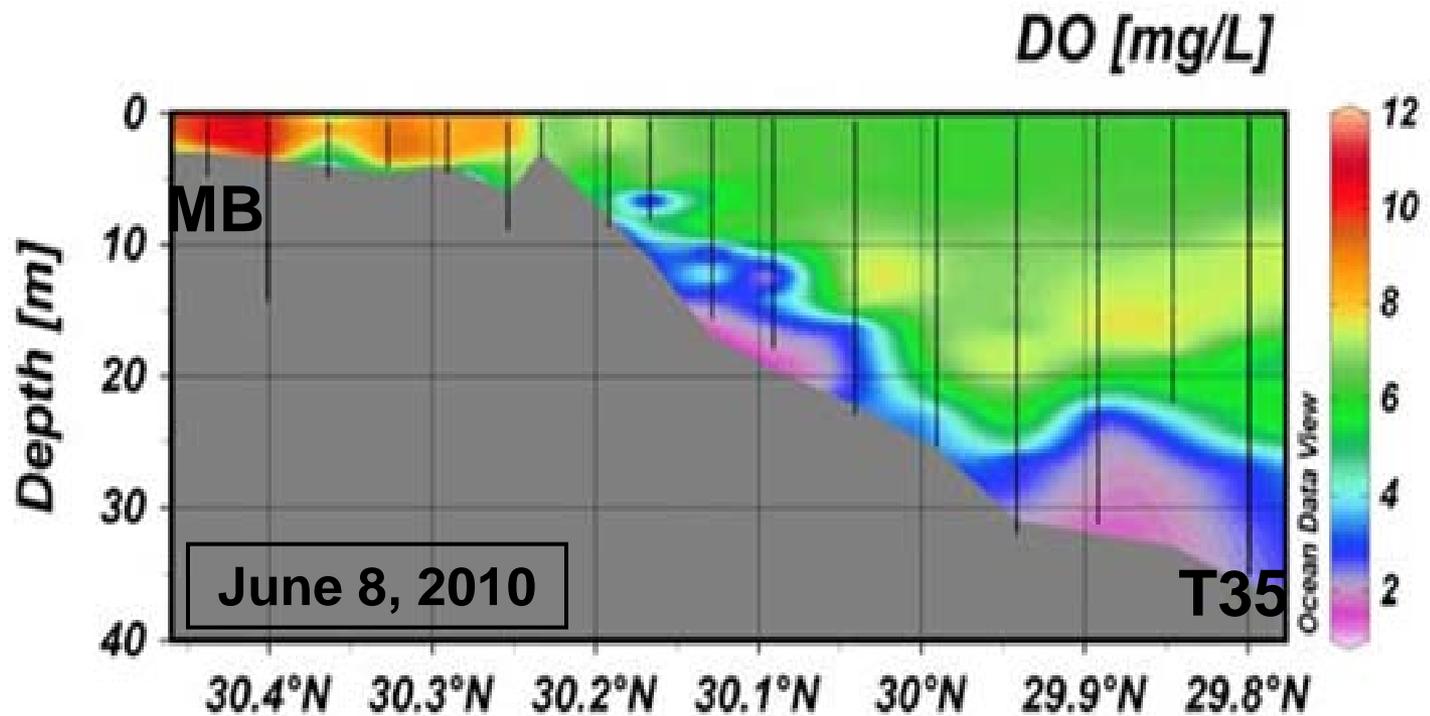
# Classical Autotrophic Food Web



# Heterotrophic Food Web



# Hypoxia



# Summary and Conclusions

Continuing investigations:

- Shifts in abundance and composition: oil or climatology?
- Phase shift from autotrophy to heterotrophy?
- Carbon from petroleum a supplement to the system?



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# References

- Federal Interagency Solutions Group, Oil Budget Calculator Science and Engineering Team. 2010. Oil budget calculator: Deepwater Horizon—technical documentation. November 2010.
- Graham, W.M., R.H. Condon, R.H. Carmichael, I. D'Ambra, H.K. Patterson, L.J. Linn, and F. J. Hernandez, Jr. 2010. Oil carbon entered the coastal planktonic food web during the Deepwater Horizon oil spill. *Environmental Research Letters* 5:045301 (6 pp.), doi:10.1088/1748-9326/5/4/045301