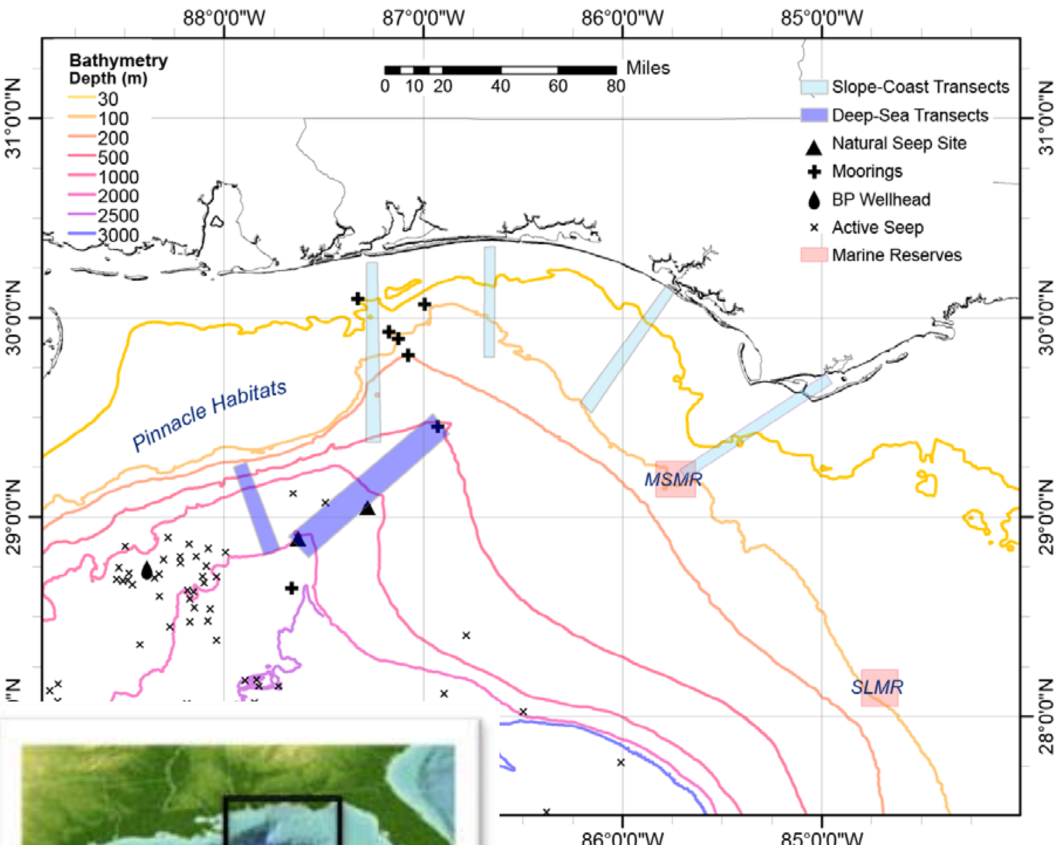
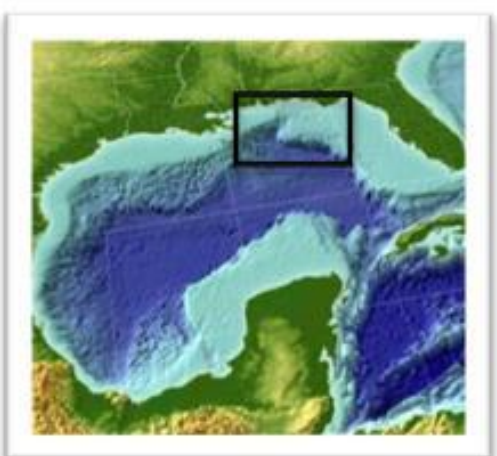
Deep-C Study Area





SPATIAL SCALE

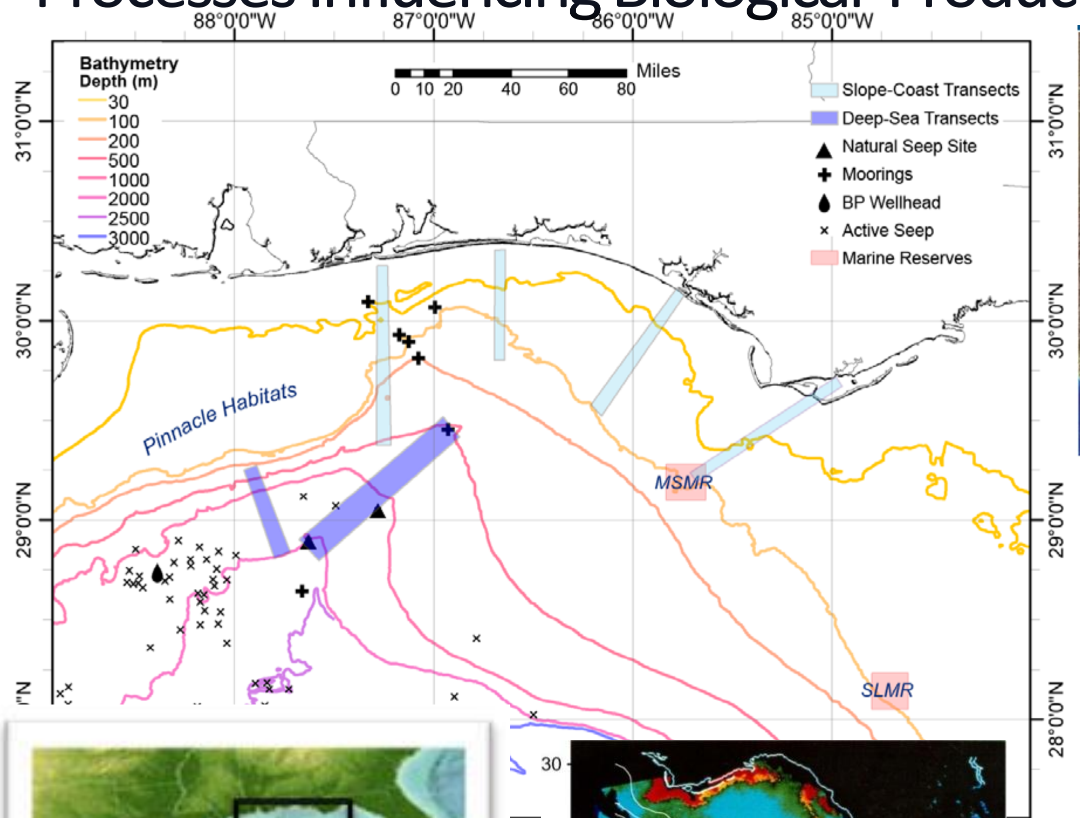
- Shallow shelf-shelf edge
  - ➢ within MPAs
  - ➢ outside MPAs
- Slope
- De Soto Canyon
- Deep Sea
  - ➢ natural seeps (+,)
  - ➢ non-seep sites ▲

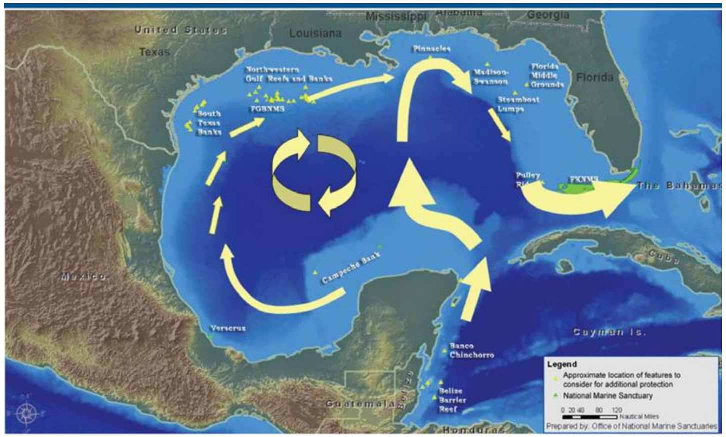
TEMPORAL SCALE

- April 2010-2020 (?)
- Geologic time

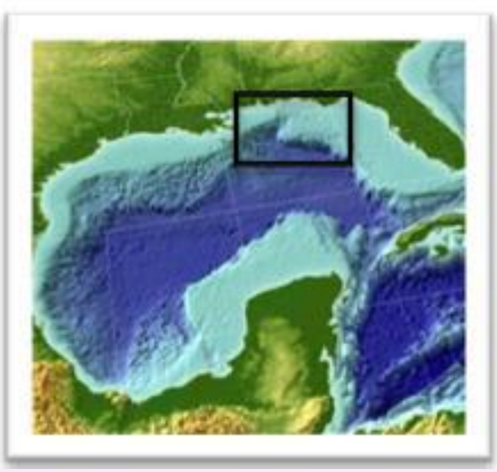
Ecological Pathways

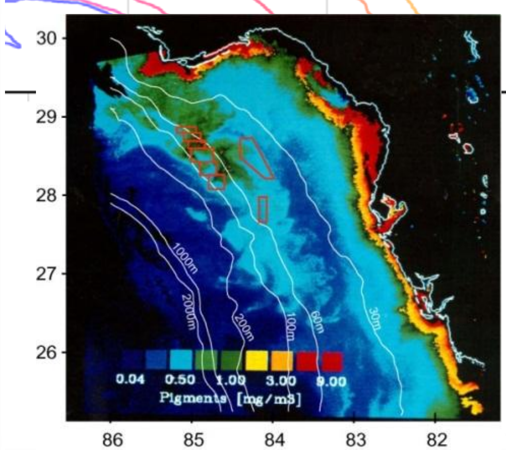
Processes Influencing Biological Productivity





TRANSPORT

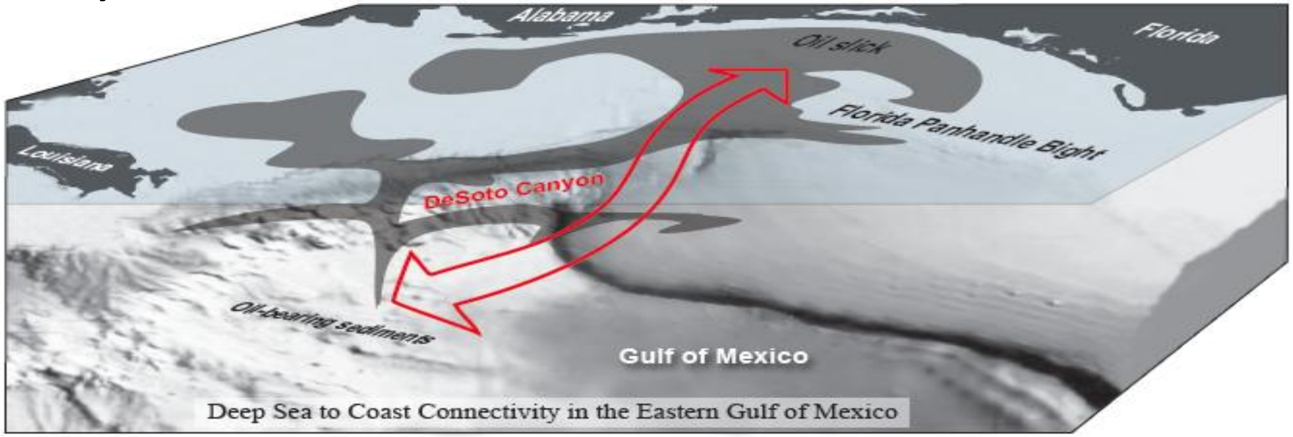




FUEL

Ecological Pathways
Overview

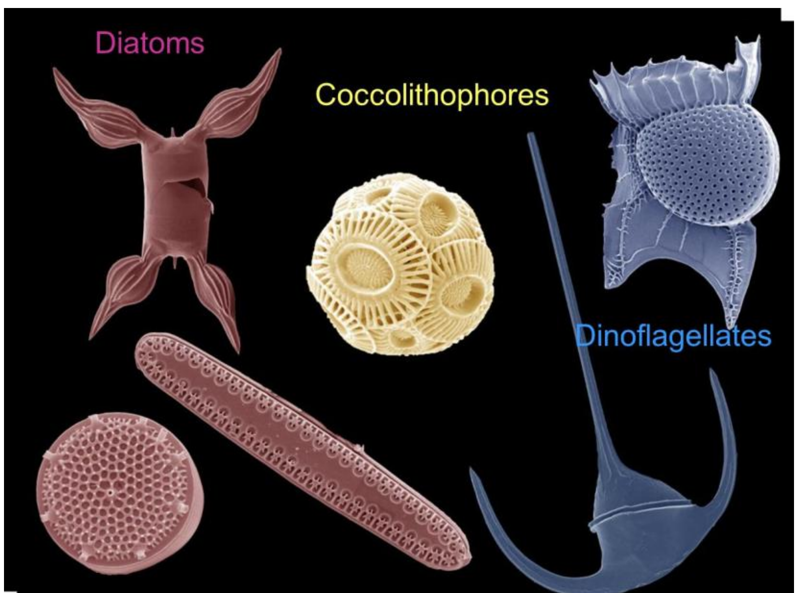
- To evaluate biological diversity and trophic interactions among organisms w/ impact of oil, dispersants other events
  - deep-sea benthos ↔ coast
  - 1° producers → apex predators
- Evaluate versus backdrop of hydrology & geomorphology that influence distribution, fate of particles & dissolved material
- Combine w/ chemical, physical components in Food Web and Earth System Models

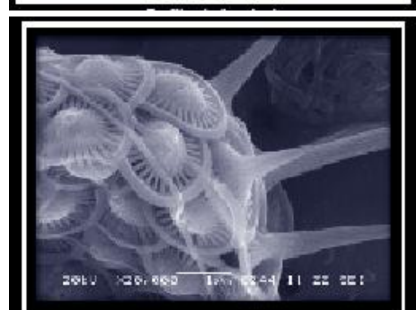


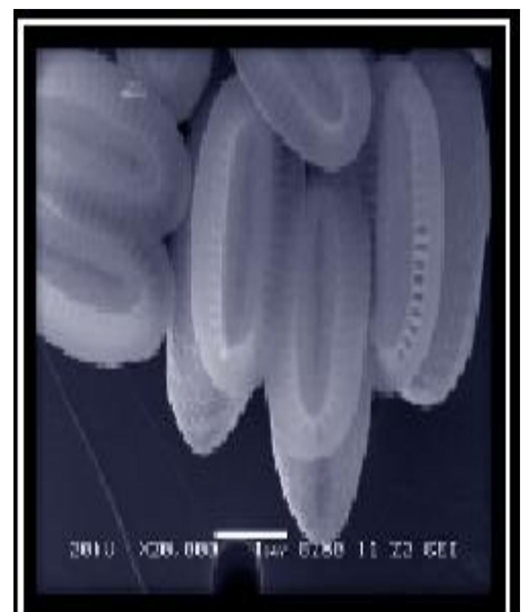
Deep Sea to Coast Connectivity in the Eastern Gulf of Mexico

Ecological Pathways
Primary Production

- To trace BP oil & dispersant impacts on diatoms, calcareous nannoplankton, & related protists in the NE GOMs
  - Focus on skeleton-bearing species (calcite, silicate)
  - Compare living with fossil forms in post spill & older sediments







Woody Wise (FSU) & James Nienow (Valdosta State University)

Ecological Pathways

Primary Production – Method & Outcome

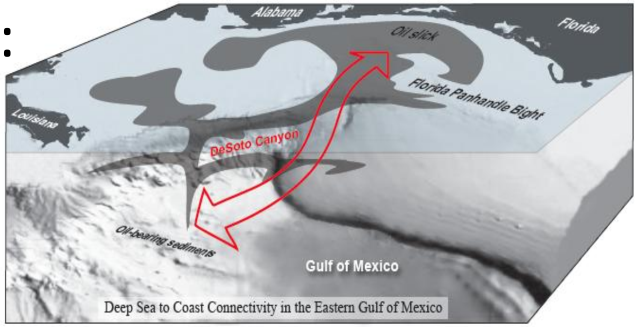
- Sample photic zone @ 20 m intervals with rosette sampler
  - Diatoms
  - Calcareous nannoplankton
  - Water chemistry
- Filter onboard ship for future analysis using SEM

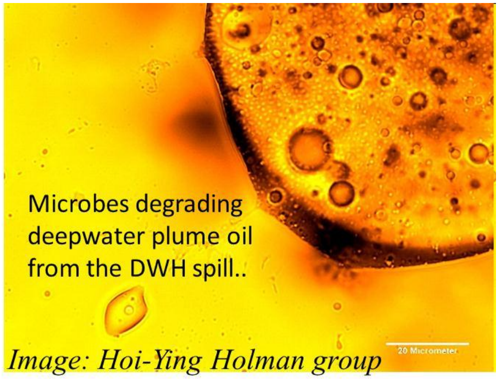
- To determine the ecological response at the base of the food chain in the photic zone to DwH and other anthropogenic events
  - Skeletal remains leave sedimentary record
  - Provide support for De Soto Canyon conduit hypothesis
  - Foraminiferan skeletal deformities ↑ in presence of n-alkanes in sediment

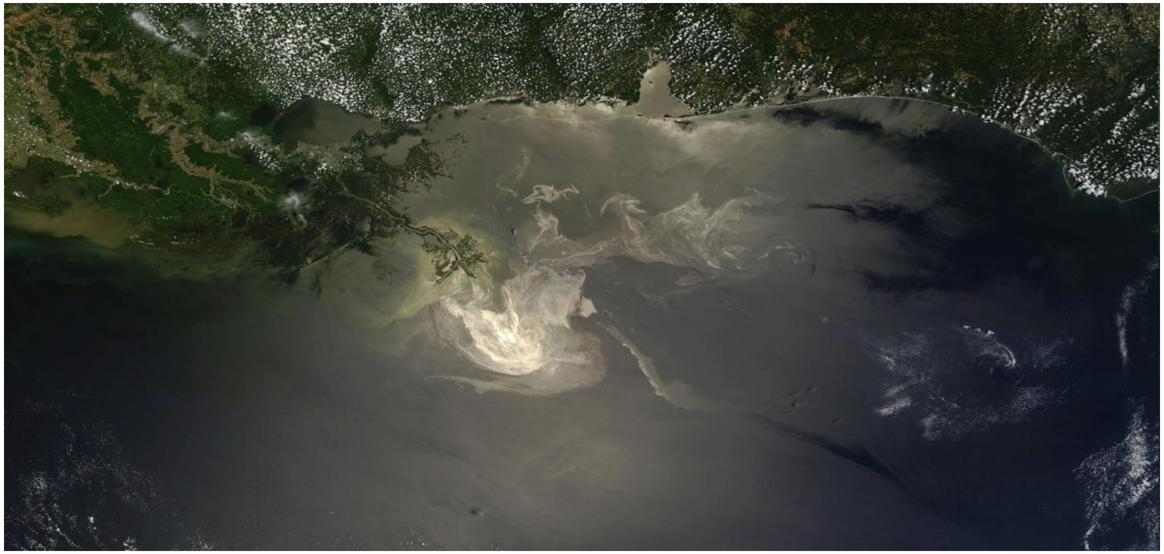
Woody Wise (FSU) & James Nienow (Valdosta State University)

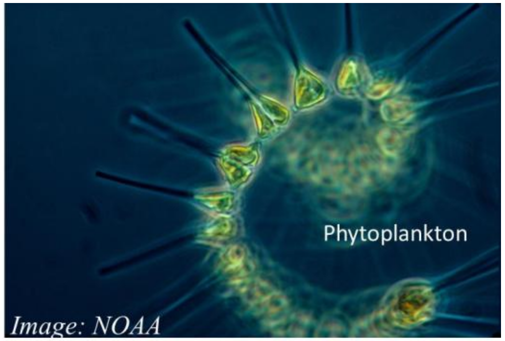
Ecological Pathways
Microbial Component

- To quantitatively compare the influence of:
  - ➢ settling crude oil (old organic matter)
  - ➢ algal blooms (new organic matter)
- On sediment physical & chemical characteristics
- On sediment-dwelling microbes









Markus Huettel (FSU) & Joel Kostka (Georgia Tech)

Ecological Pathways
Microbial Component –Hypothesis

- Pulses of oil and phytoplankton change permeabilities & mixing regime in sediments across the shelf & slope;
- These changes affect
    - ➢ sediment microbial community function
    - ➢ microbial community composition in concert with physico-chemical variables
- **Using sediment cores mesocosm experiments**
    - Create time-series database that populates model of depth-specific impact petroleum HC deposition in shelf sediments

Ecological Pathways
Microbial Component –Outcome

OIL from DwH spill had **profound impact** on the abundance and community composition of microbes in sediments.

- Heavy oil deposition = 2-fold ↓ sediment permeability, reducing pore water & air circulation.
- Despite this, embedded oil → bloom sedimentary bacteria @ ~4- fold →O2-consumption rates in oiled layers compared to clean sands
- Impact mimicked that of an algal layer imbedded in the beach sediments by wave action. .

Ecological Pathways
Microbial Component –Methods

Deep-C CONSORTIUM

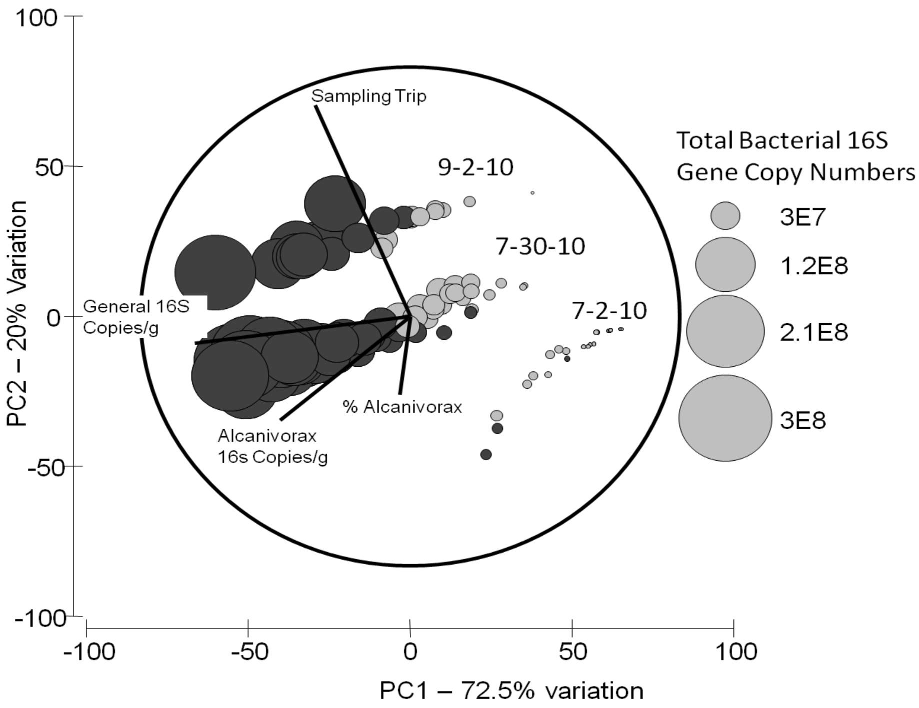
- Characterize microbial communities w/ coupled culture-based & molecular approaches
  - 24 strains oil-degrading bacteria identified in oil containing sediments
  - Developed genetic sequencing & phylogenetic characterization methods for sedimentary microorganisms
- O_2 present - cultures from oiled sediments degrade DwH oil in days
- O_2 absent - oil persists for months

Oil-degraders = 3 to 4 orders of magnitude higher in oiled sediments than in “clean” sediments

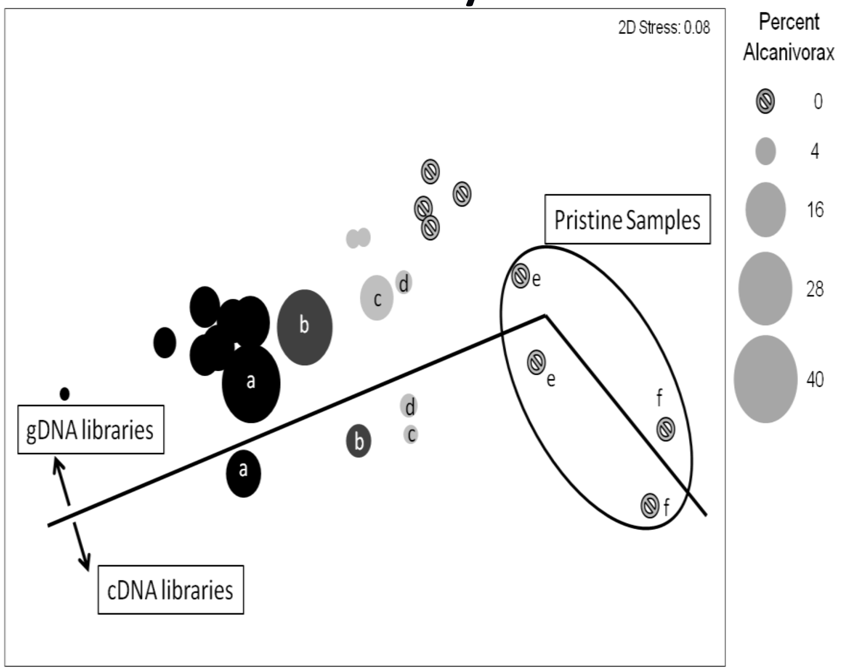
Joel Kostka (Georgia Tech)

Ecological Pathways
Microbial Component – Outcomes

Molecular-based Enumeration

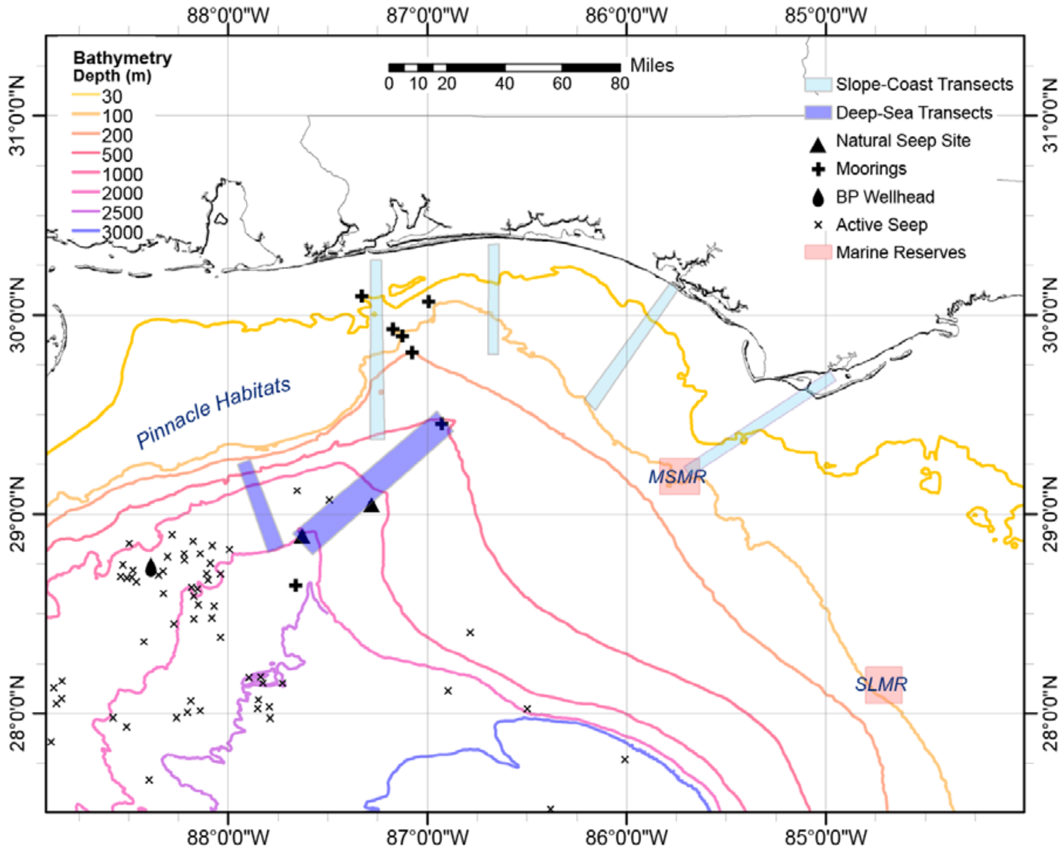


Impact on Community Structure



- Microbial bloom of oil-degraders covaried with respect to oil contamination
- Pronounced response of total and active communities to oil presence

Ecological Pathways
Microzooplankton & Water Quality



Monthly (BP-FIO) thru April 2012
Quarterly (DEEP-C) thru fall 2015

Examines influence of
- Upwelling
- Mixing with MS river water, Mobile Bay, and Apalachicola discharge

Dick Snyder (UWF) & Wade Jeffrey (UWF)

Ecological Pathways
Microzooplankton & Water Quality

Water Column Parameters

Physical & Chemical

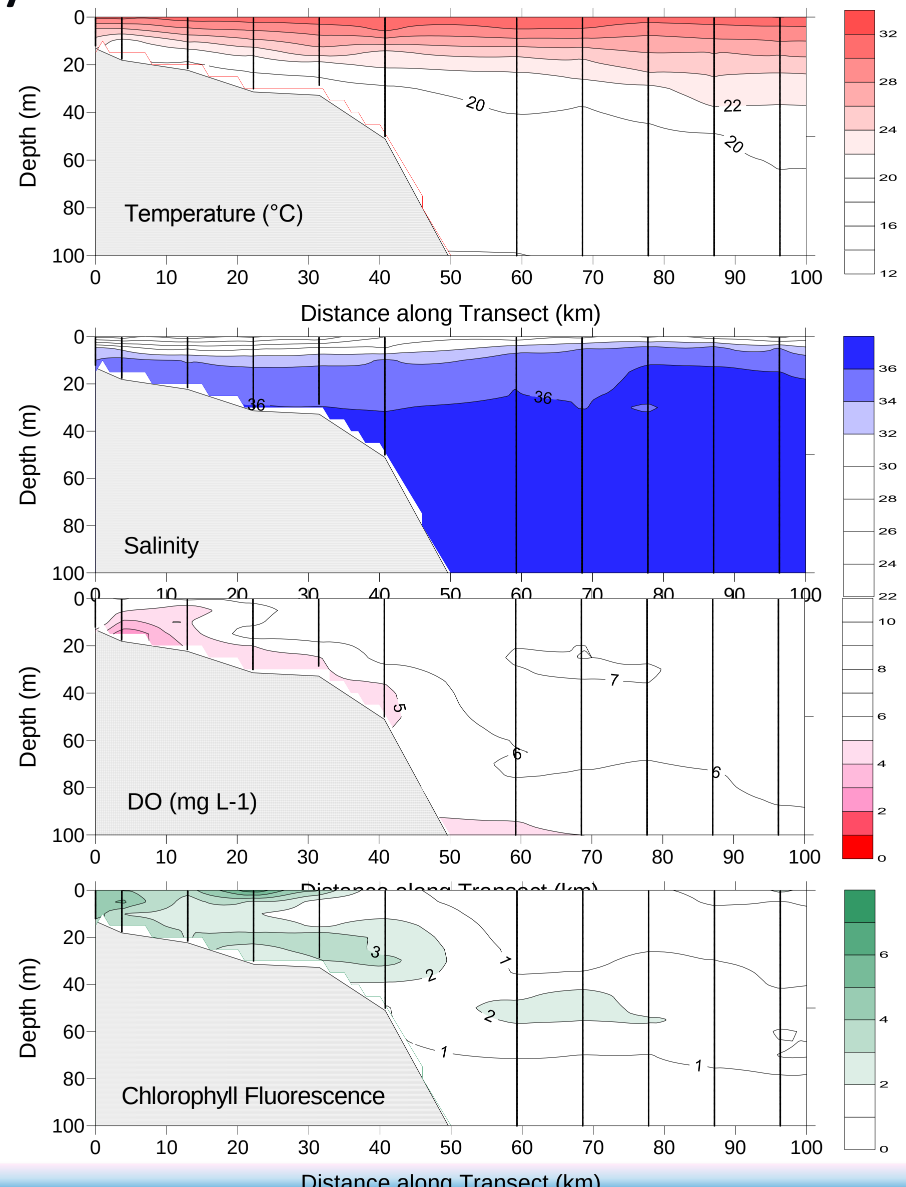
- ADCP & CTD profiles
  - ➢ Salinity T, DO, Chl-a, CDM, Turbidity
- Light - PAR, UVA, UVB
- Nutrients – Dissolved Ammonium, nitrate, orthophosphate, TKN, Phosphorous, Chl

Biological

- Phytoplankton activity
- Bacterioplankton (N), activity
- Microzooplankton (N), Diversity

Sediment Parameters

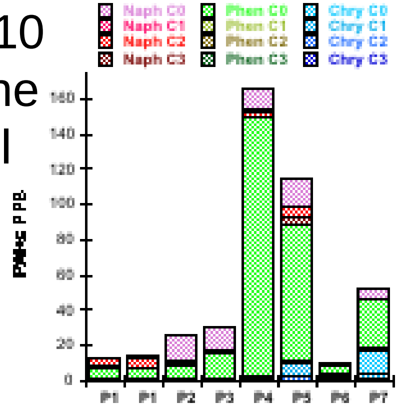
- PAHs , Chl
- Microbial community - Diversity (DNA sequencing)



Dick Snyder (UWF) & Wade Jeffrey (UWF)

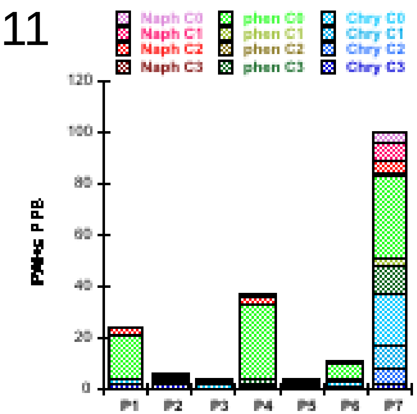
Pensacola | Choctawhatchee | St Andrews

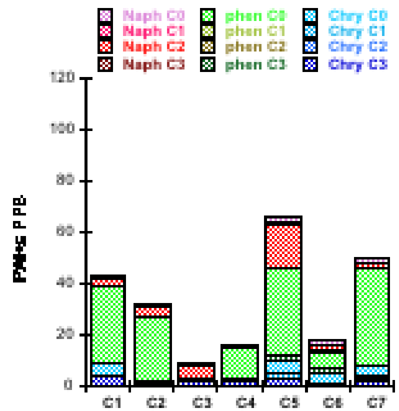
June 2010 during the oil spill

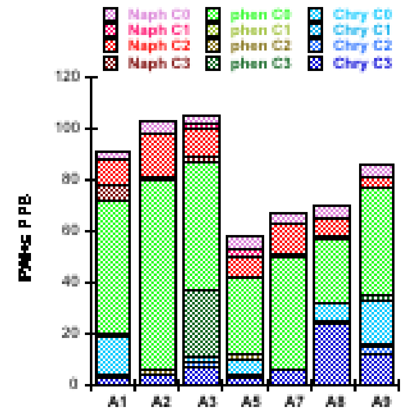


Sediments contain trace amounts of PAHs, decreasing over time

Feb 2011

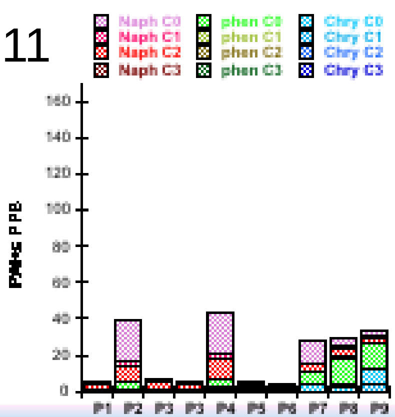


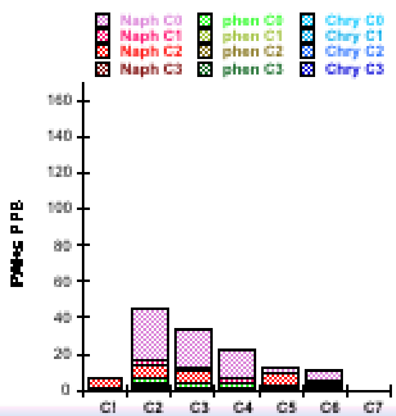


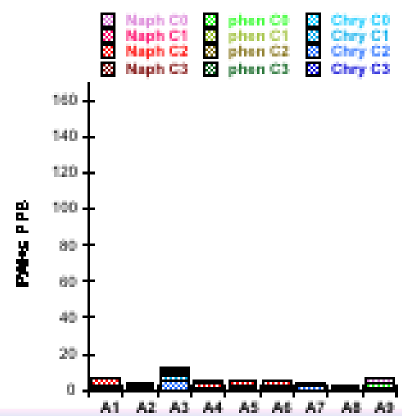


Variability due to sampling, variable amounts of biota accummulating PAHs.

June 2011



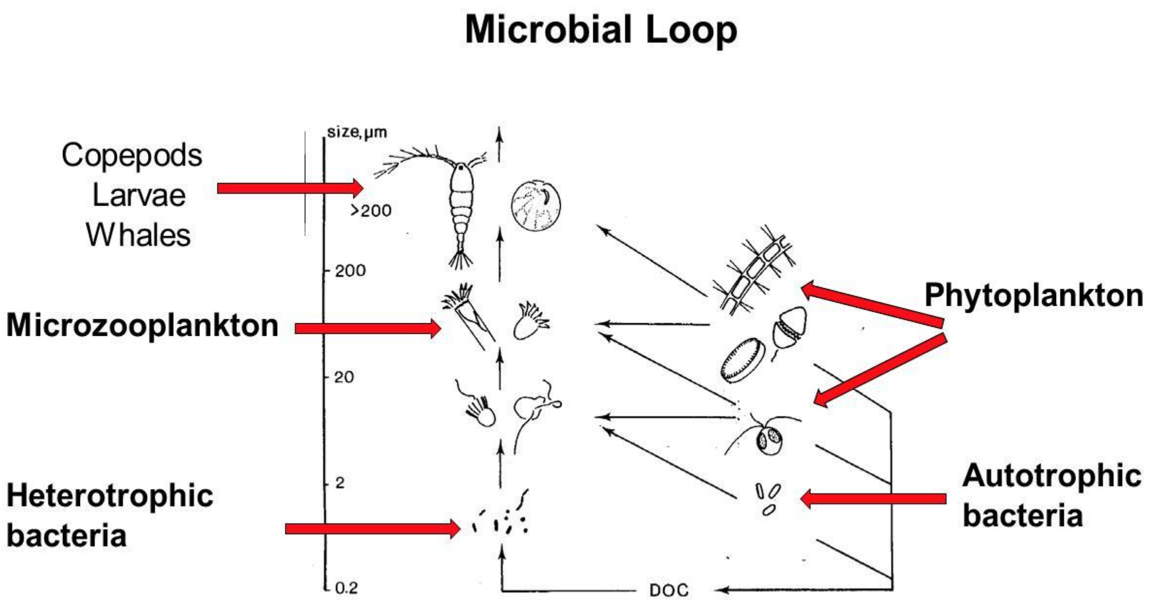




What is “normal” background for sediments of the study area?

Ecological Pathways
Microzooplankton & Water Quality

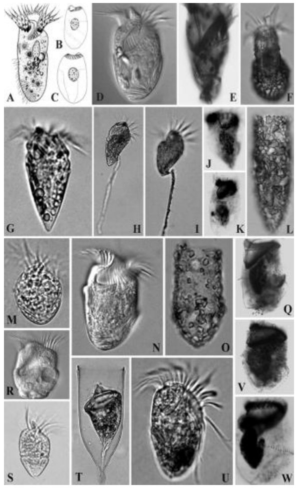
- Consume primary and bacterial production
- Produce food for zooplankton, larvae

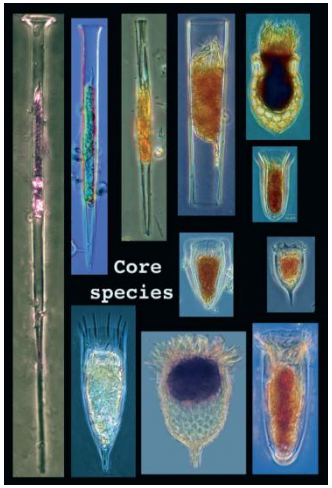


Fenchel, T. 1987. *Ecology of Protozoa* Brock/Springer

Objectives:

- To determine if flow controls on MS and Apalachicola affect production around De Soto Canyon
- To determine how production is mediated by oil & dispersants



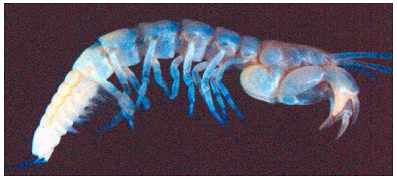


Ecological Pathways
Benthic Communities - Macrofauna

- Quantify benthic macrofaunal assemblages across seep & non-seep sites
  - spatial & temporal differences
  - biological diversity
  - species-specific distributions & abundances
- Determine presence & effect of hydrocarbon signal (natural & discharged)

Seep Community

Benthic macrofauna



Megafauna photosurvey

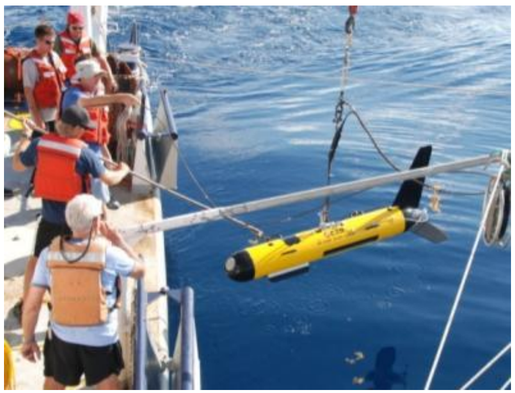
Ian MacDonald (FSU) & Amy Baco-Taylor (FSU)

Ecological Pathways
Benthic Communities - Macrofauna

Deep-C CONSORTIUM

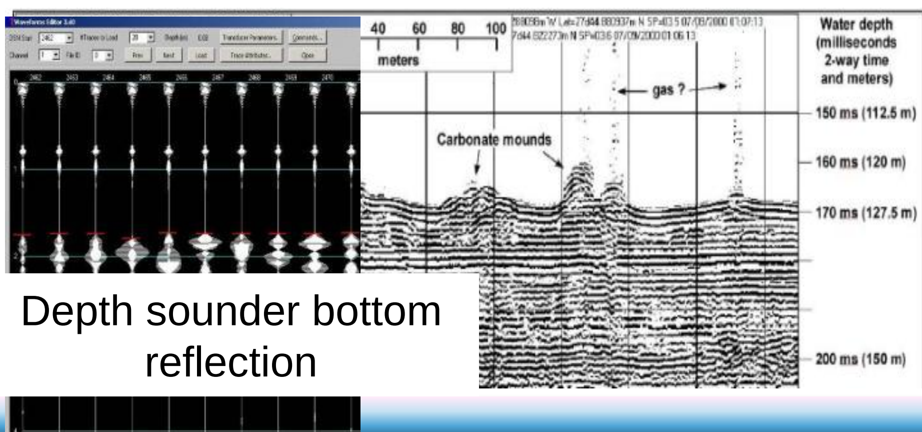
Methods

Acoustic Imaging



Sidescan sonar
(topography, habitat)

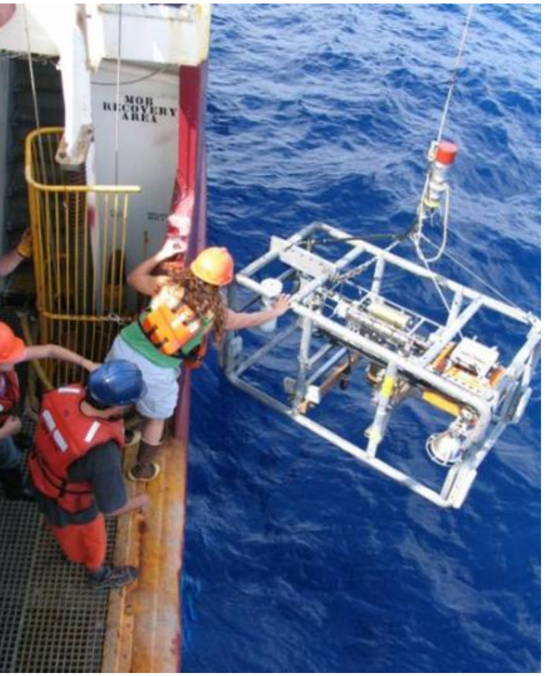
Subbottom CHIRP
(geologic framework)



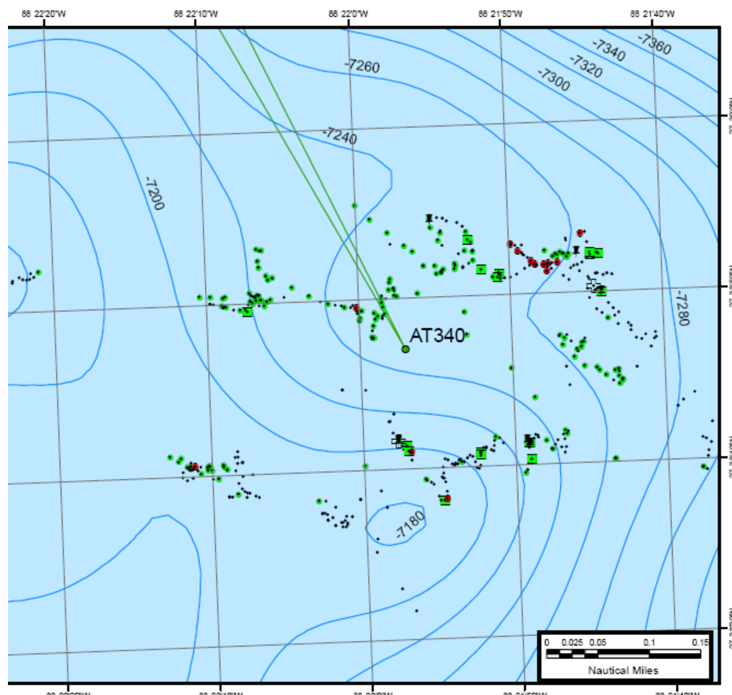
Depth sounder bottom reflection

Videographic Imaging

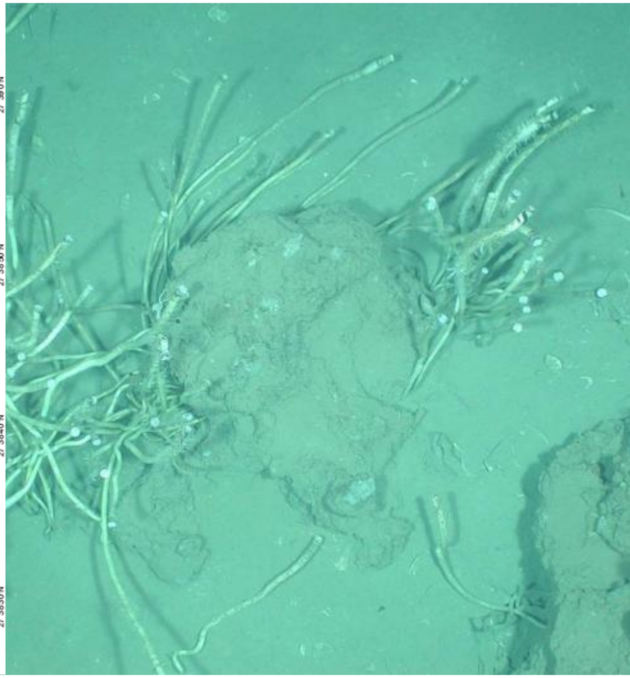
Ecological Pathways
Benthic Communities - Macrofauna



Benthic imaging platform with USBL navigation deployed from surface ship – e.g. WB2

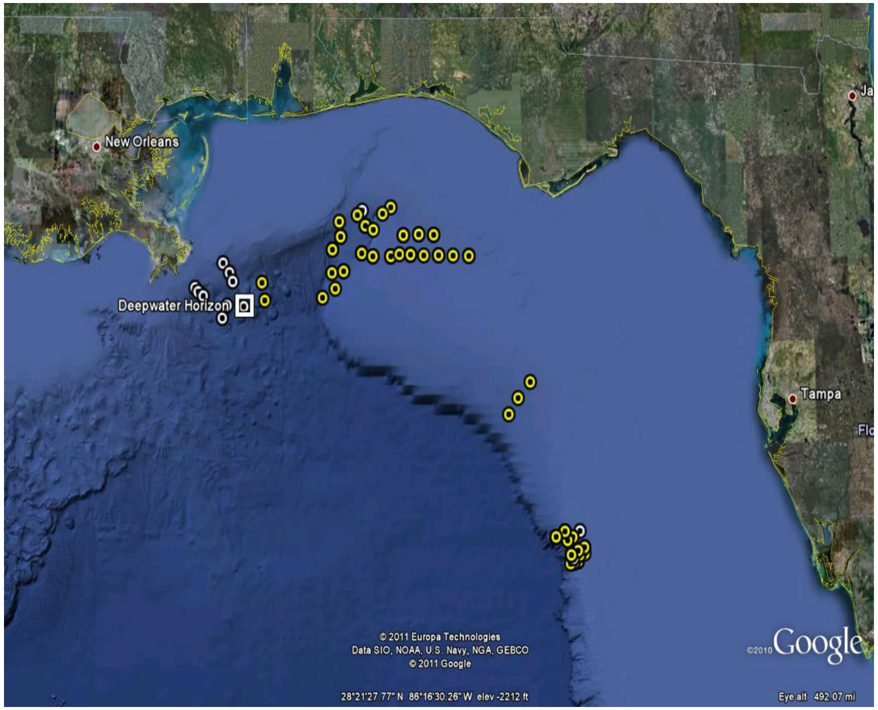


Real time video transects and high resolution still photographs .



Diagnostic bottom features and fauna delineate natural hydrcarbon seeps and/or other benthic habitats.

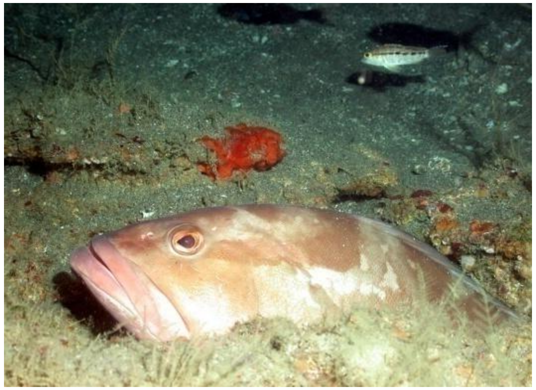
Ecological Pathways
Benthic Communities – Fishes



Goals

- Conduct Meta-Analysis to define spatial and temporal differences in faunal diversity, distribution, and abundance
- Determine relationship b/w exposure to PAHs and fish health (relative to age, size, and reproductive condition (Non-consumptive)

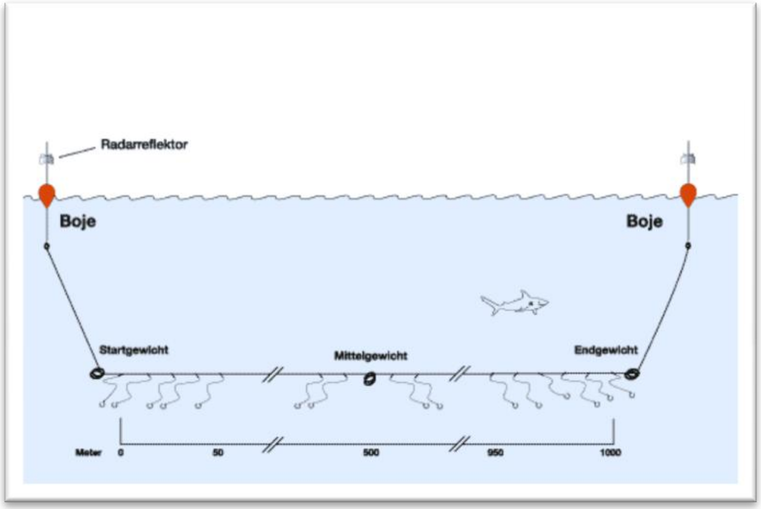


Dean Grubbs, Chris Koenig, Felicia Coleman, (FSU) , Mark Hay (Ga Tech), Jim Gelstleoicher (UNF))

Ecological Pathways

Benthic Communities – Fishes-Sampling Methods



Longline – Slope & deep sea (200-2000 m)

Traps – Continental shelf to edge (40 – 200 m)

- Vent fish at depth (~40% depth of capture)
- Slow haul to surface

Tag w/ standard, acoustic tags

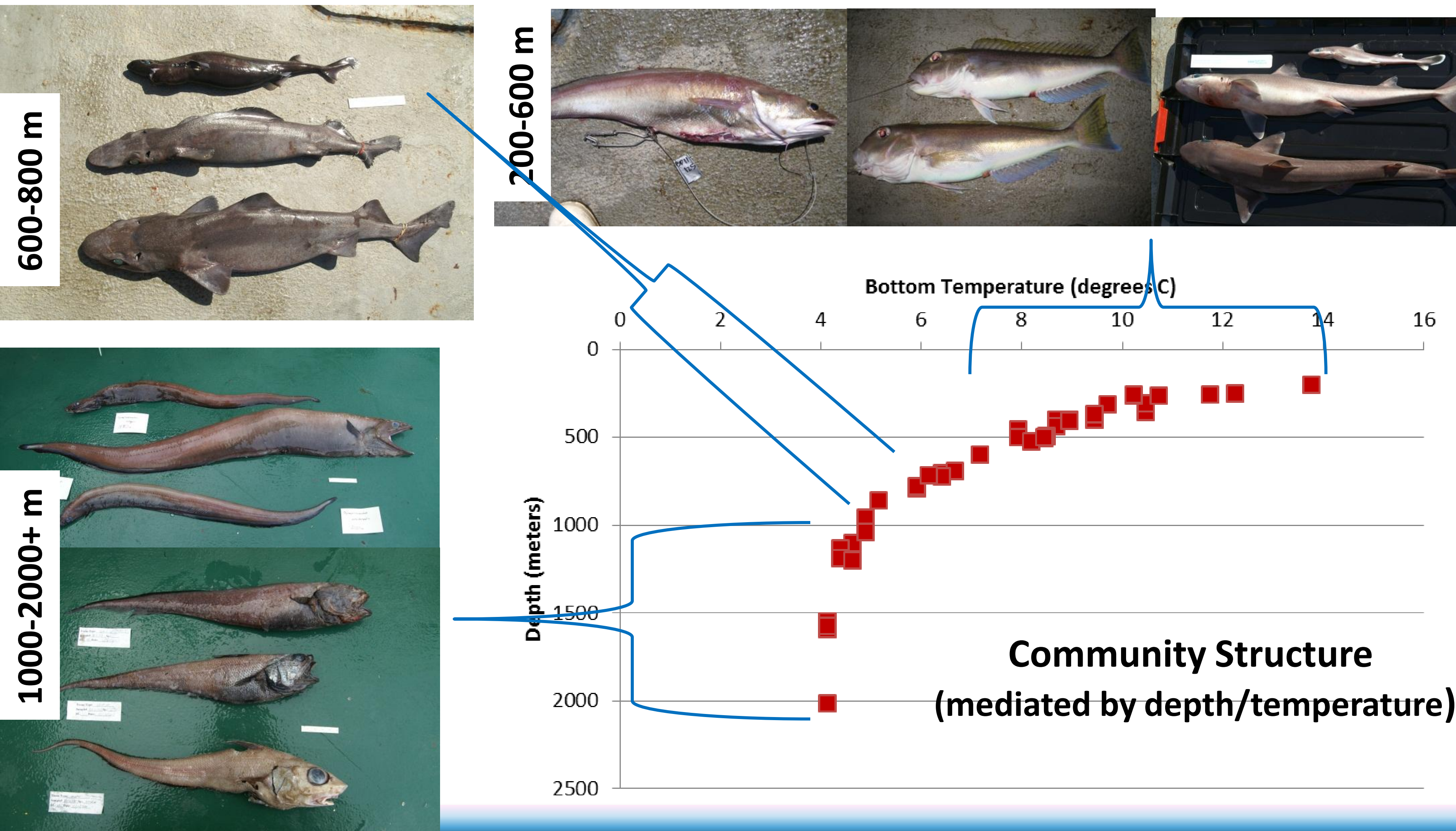
Biopsy gonad (sex, reproductive condition, atresia

Spines & Rays (age)

Tissue Samples

- Genetics
- Isotopes (diet)
- PAH analysis
- Liver & bile (dead fish)

Ecological Pathways
Benthic Communities – Fishes



Ecological Pathways
Food Web Model

Characteristics:

- Spatially-explicit 3-D biogeochemical marine food web model (e.g., ATLANTIS)
- Submodels:
  - ➢ hydrographic processes
  - ➢ chemical & biological factors that influence ecological processes

Use to:

- Evaluate ecological, social, & economic effects of DwH oil discharge, other extreme events that influence ecosystem health & resilience
- Conduct risk analysis
- Identify critical data gaps
- Link to Earth System Model