



Subsurface Monitoring Deepwater Horizon Response

Region 6 Regional Response Team
Winter Meeting
1-2 December 2010 - Addison, TX

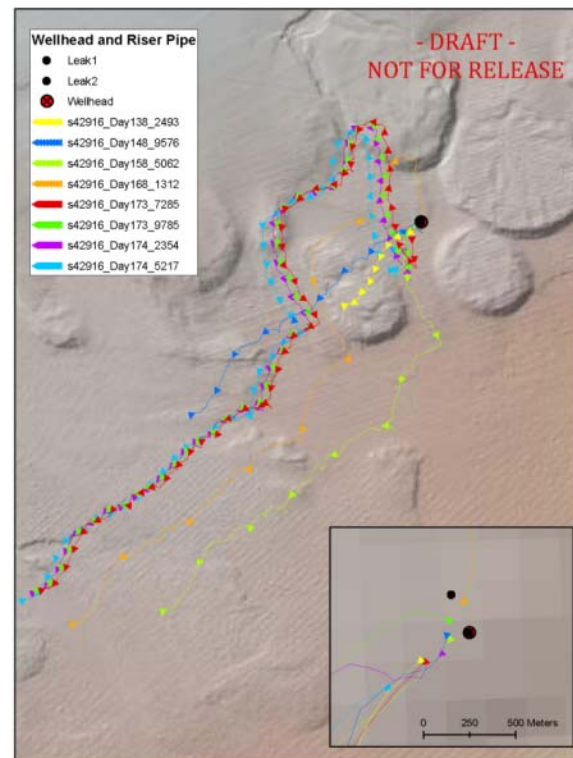
Dr. Samuel Walker
Integrated Ocean Observing System (IOOS) Program
NOAA, National Ocean Service



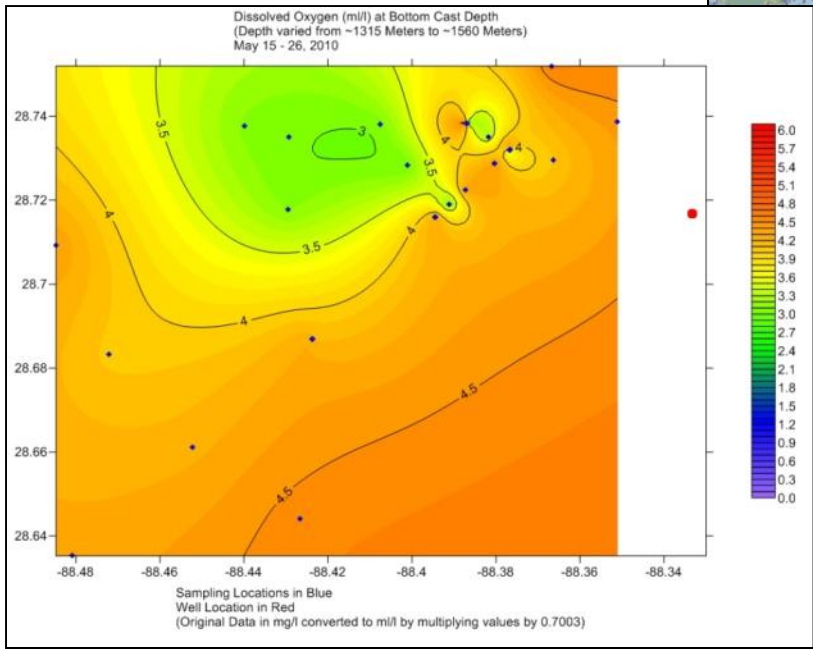
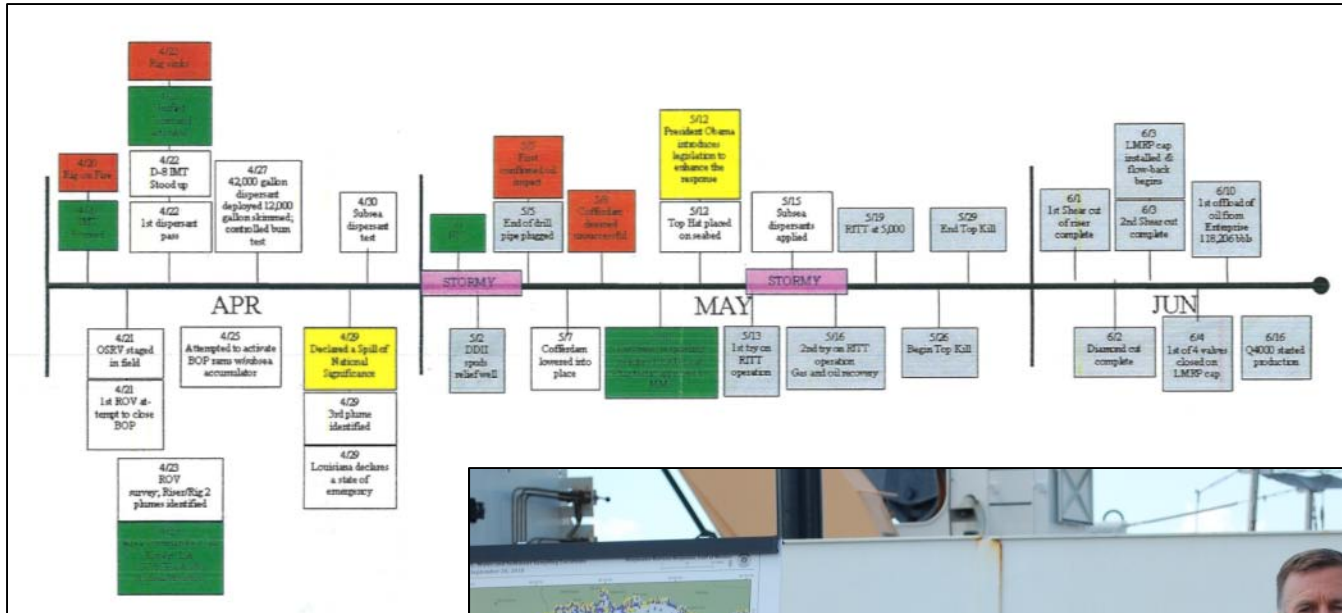
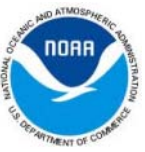
- Role and Functions
- Subsurface Monitoring
- Results and Status
- Lessons Learned

In support of the Unified Command response:

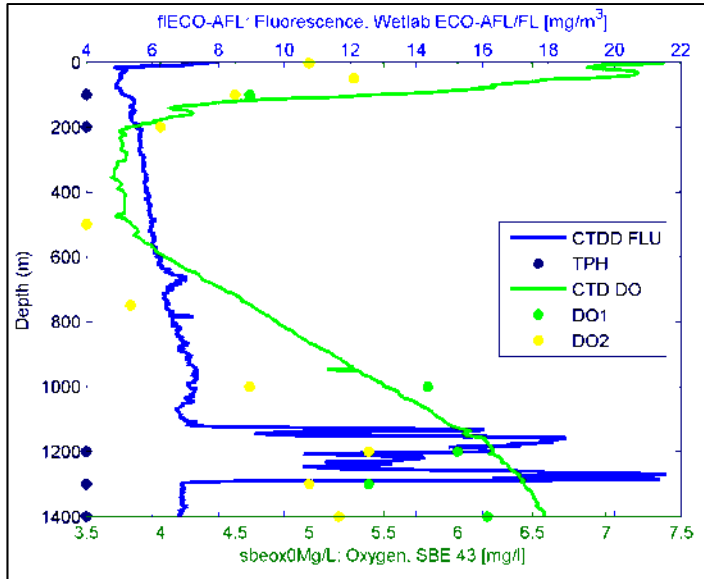
1. Characterize and determine the distribution of any subsurface oil beyond the immediate area of the release;
 - Presence/Absence (Where/Extent)
2. Identify changes in oil characteristics and transport associated with response measures at the release point;
 - Characteristics (What/Source)
3. Support verification of oil fate and transport models and
 - Fate/Transport (When/Forecast)
4. Provide context for longer-term integrated ecosystem assessment of oil spill impacts.
 - Impacts/Assessment



Addressing a Range of Operational Needs

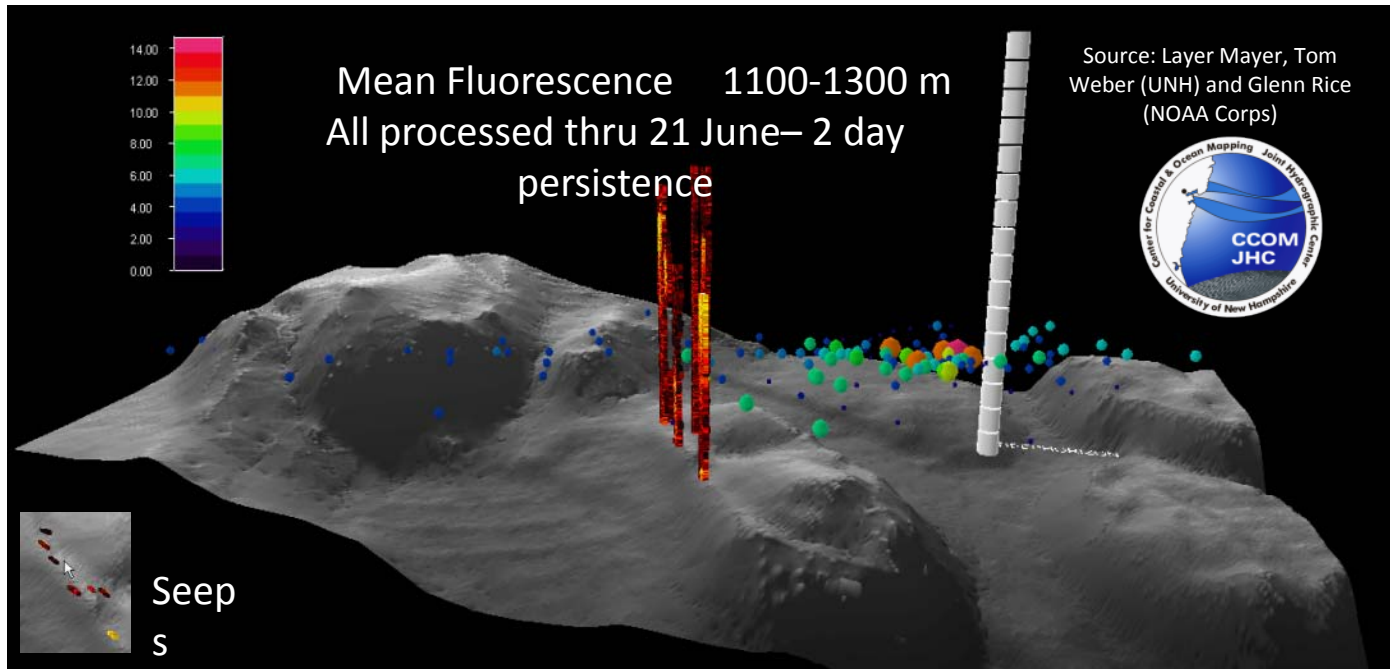


Changing Requirements

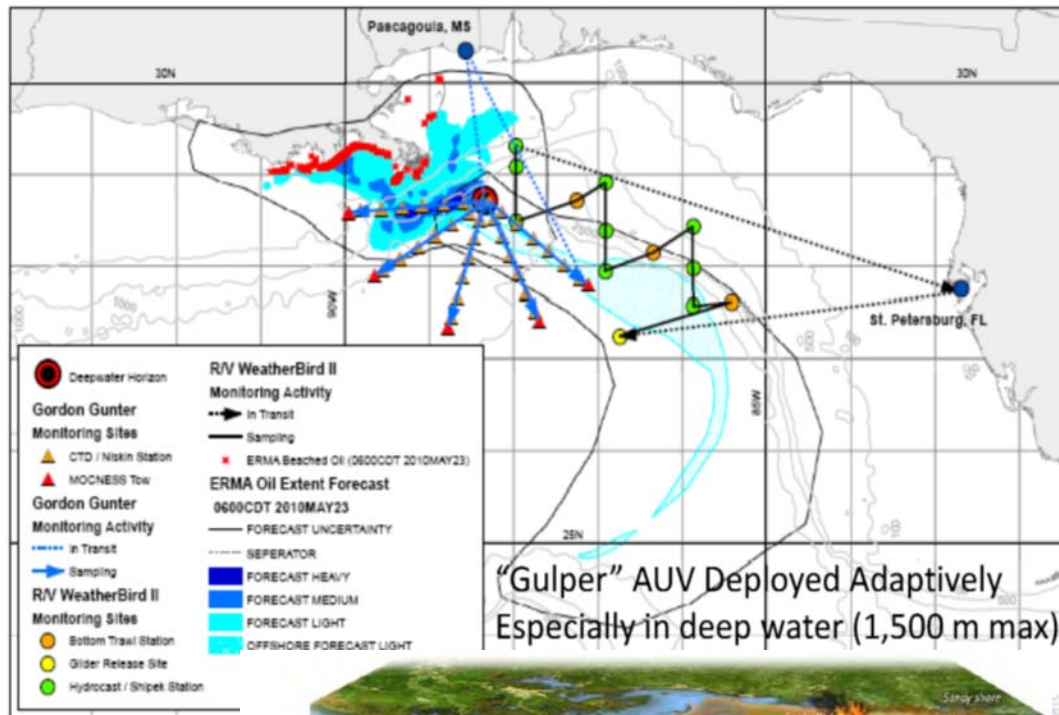
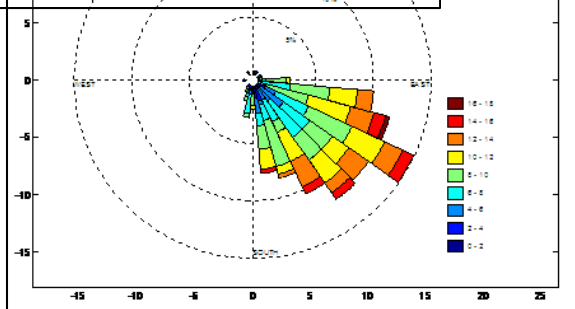
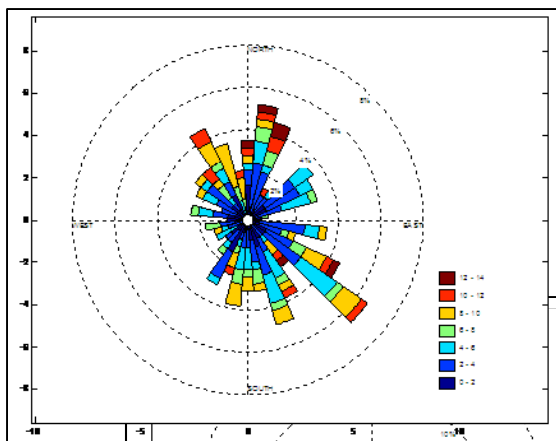


• NOAA WP-3D aircraft deployed airborne expendable current and conductivity with depth probes (AXCP and AXCTD, respectively) to provide deep-water (~1000m) profiles of currents and salinity in the vicinity of the spill and in the Loop Current and its Eddies

PROBE	PARAMETER	DEPTH	ACCURACY	ACQUISITION SYSTEM
AXCTD	conductivity/temperature	150 m	-0.05 mS/cm, 0.05 °C	PR_2
AXCP	speed/velocity	50 m	-0.02 m/sec	PR_2
AXCP	salinity/velocity/temperature	150 m	-1.0 sal, 0.05 °C	PR_0

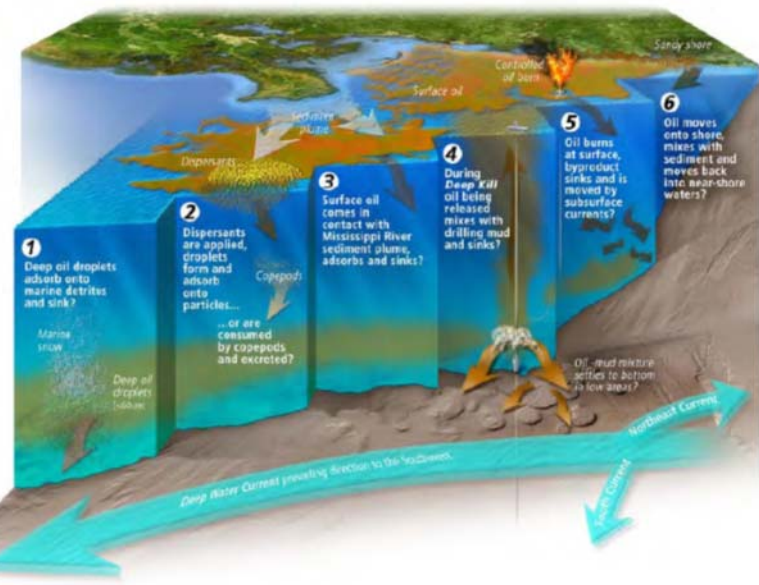
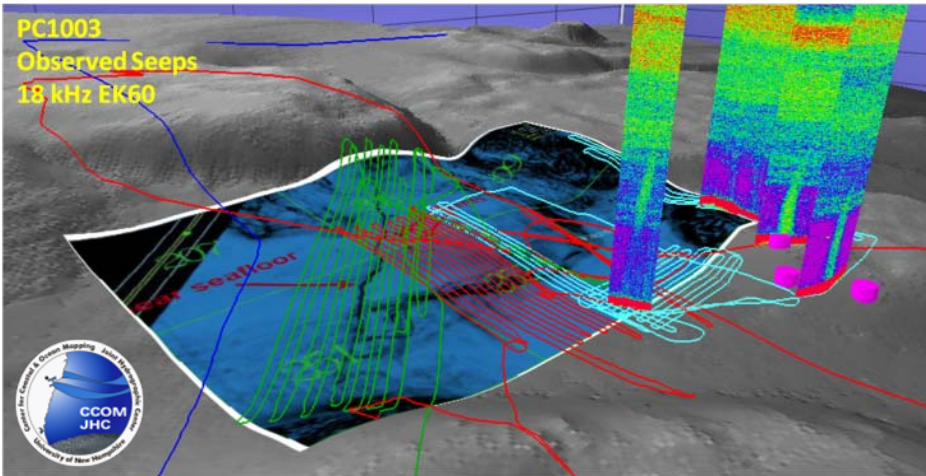


Changing Requirements



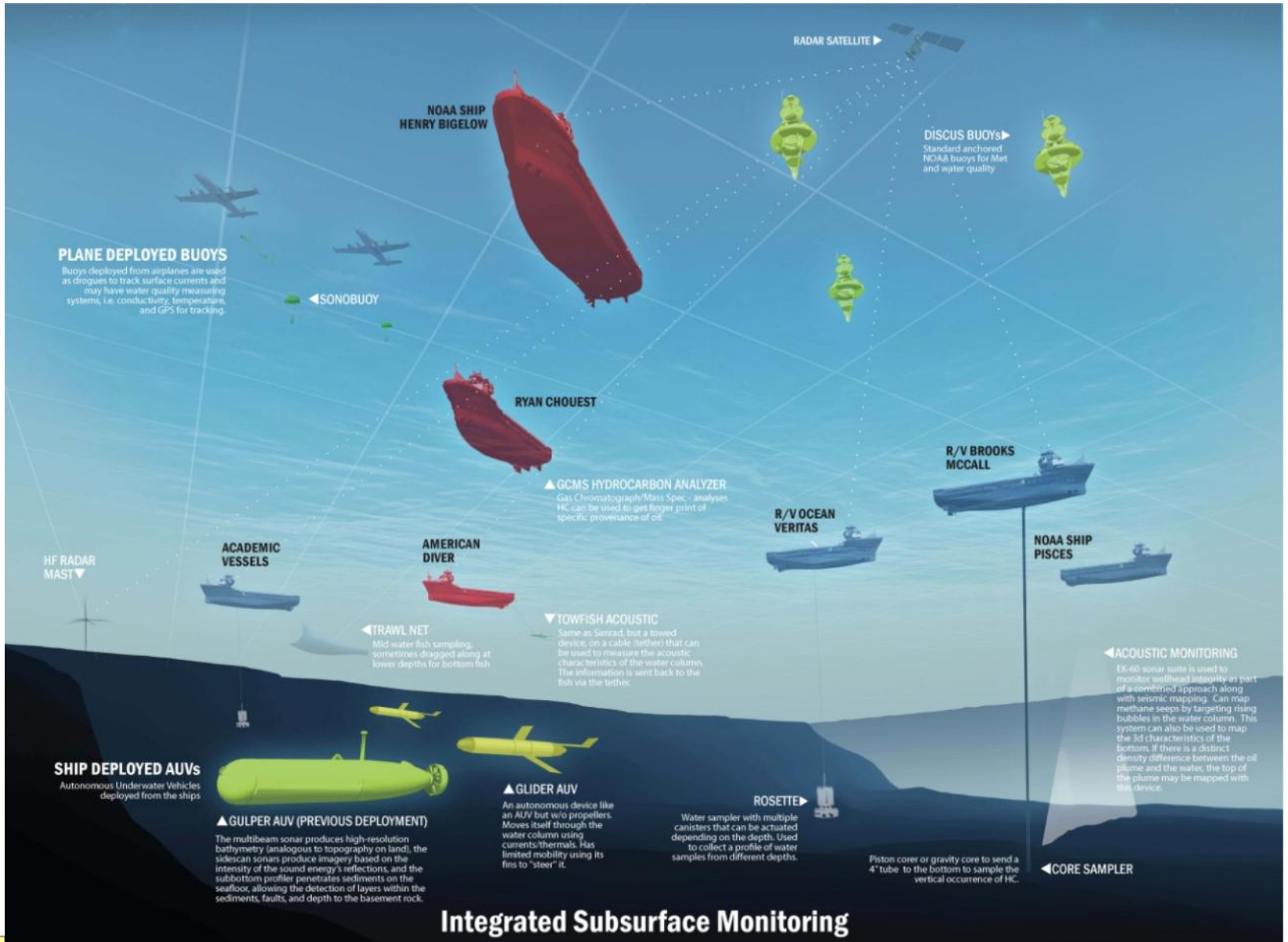
“Gulper” AUV Deployed Adaptively Especially in deep water (1,500 m max)

PC1003
Observed Seeps
18 kHz EK60



Req

Adaptive/Integrated Ocean Observing Approach



Integrated Subsurface Monitoring



Subsurface Monitoring Unit Composition



Key Positions:

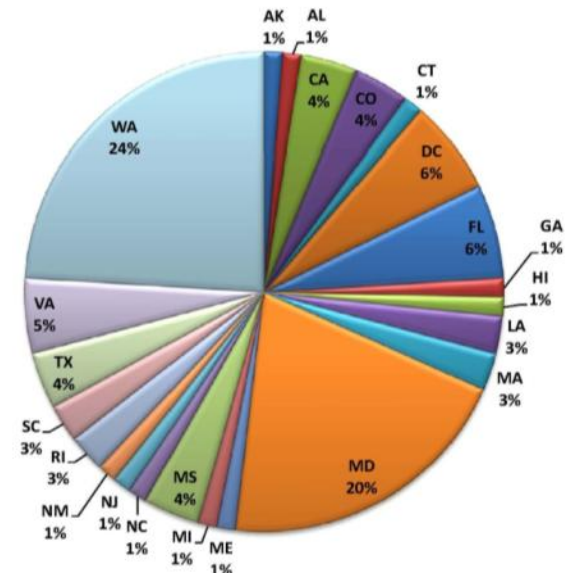
- Lead Scientist
- Chief (NOAA Corps)
- Operations/Staffing
- Logistics (NOAA/USCG)
- Data Coordinator
- GIS/SME
- Academic Liaison
- Data Embeds/IHs

- NOAA
- EPA
- USCG
- BOEMRE
- USGS
- NSF
- FL, MS, AL, LA
- NRDA/ASA

Related Teams:

- JAG
- OSAT
- Federal Data Centers
- ERMA/GeoPlatform
- Modeling

Personnel Associated with SMU -states represented



Sustained Monitoring Assets

Sub-surface assets:

- Surface vessels
- Ocean gliders
- Air-dropped profilers
- ADCPs
- Acoustics

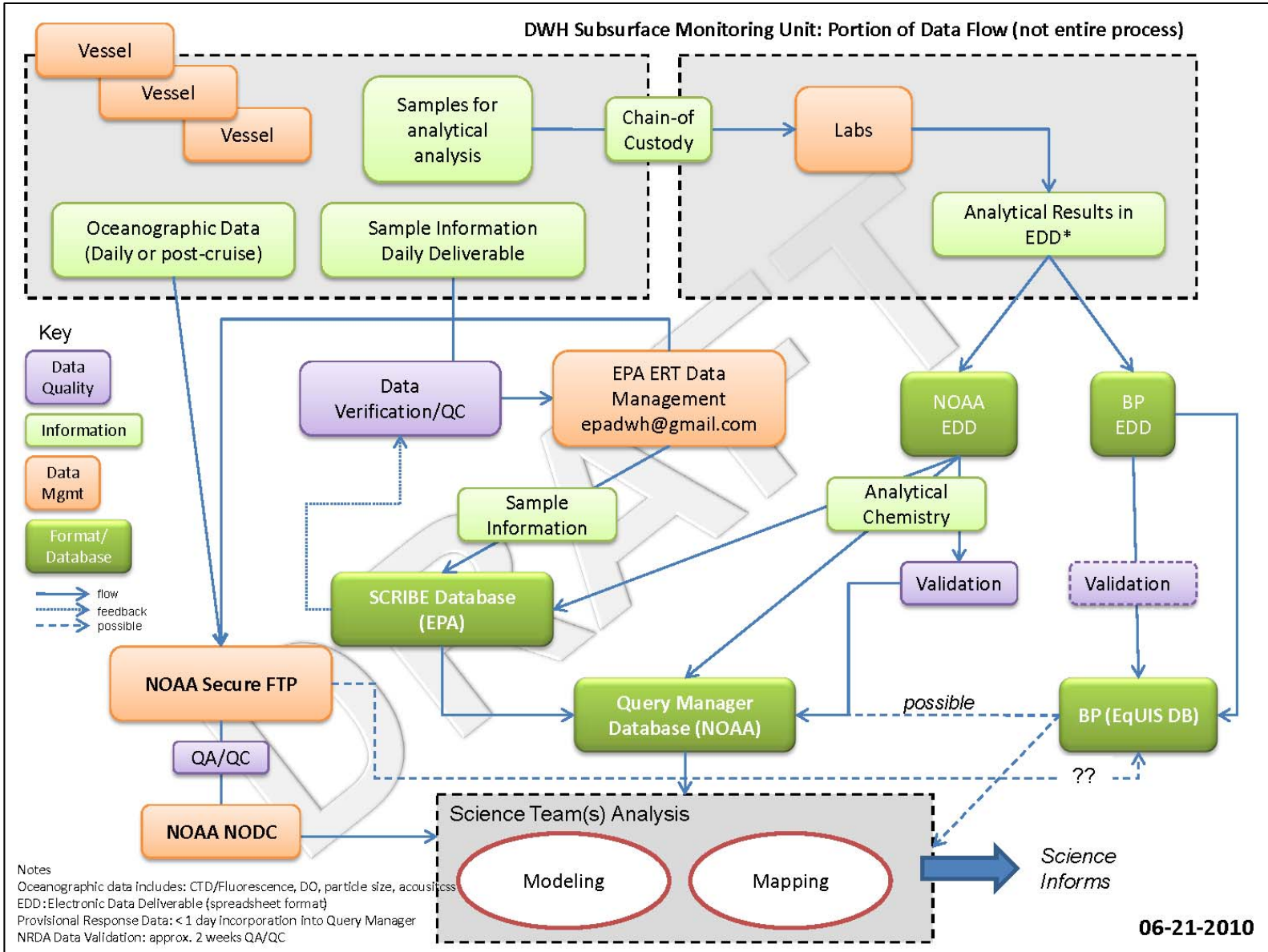
- Fluorescence
- Temperature
- Conductivity/Salinity
- Dissolved Oxygen
- LISST Particle Sizing
- TPH, TPAH, VOA

Surface assets:

- High frequency radar
- Drifting buoys
- Remote sensing
- Moored buoys
- Wave gliders

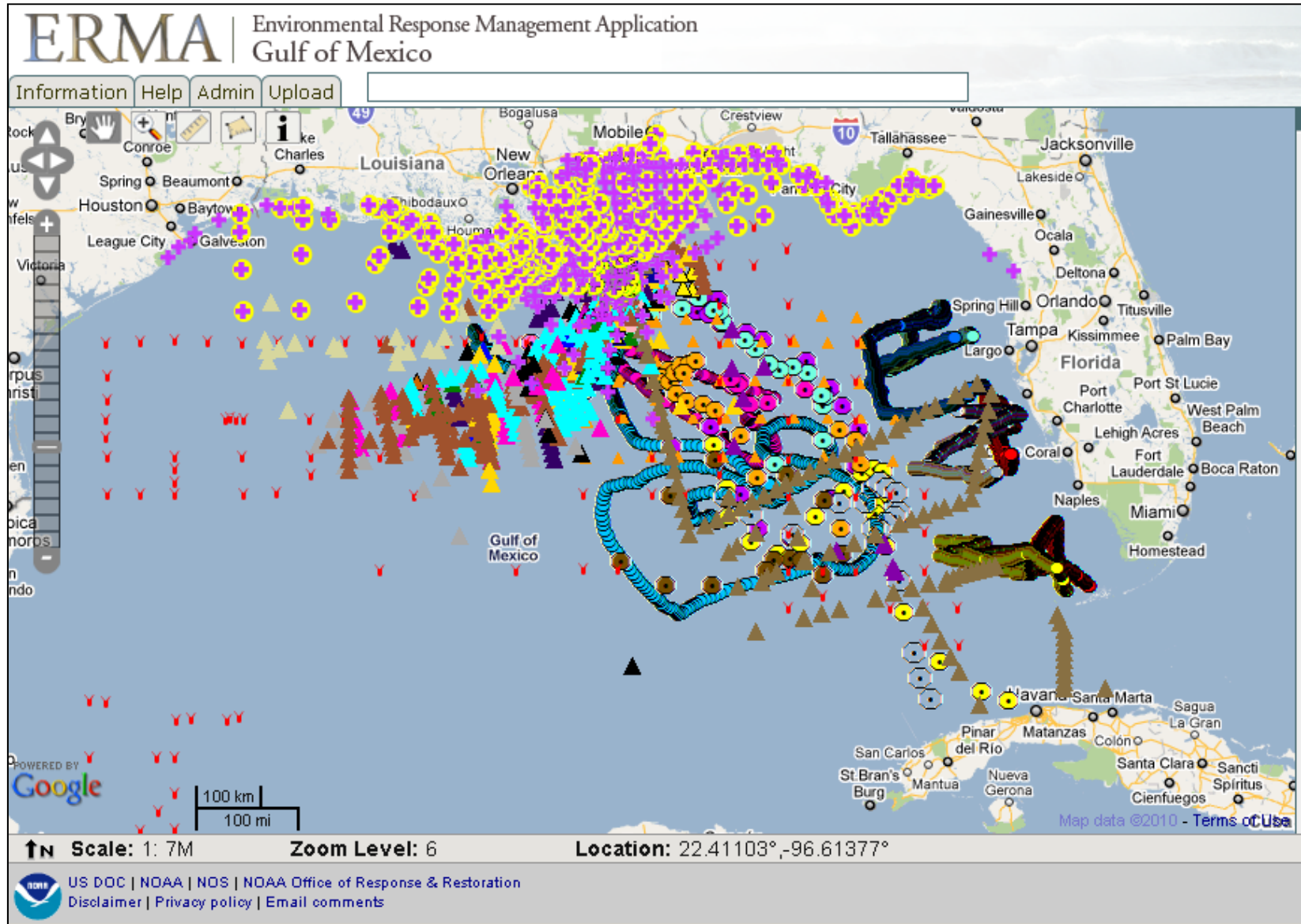


Generalized Subsurface Monitoring Data Flow





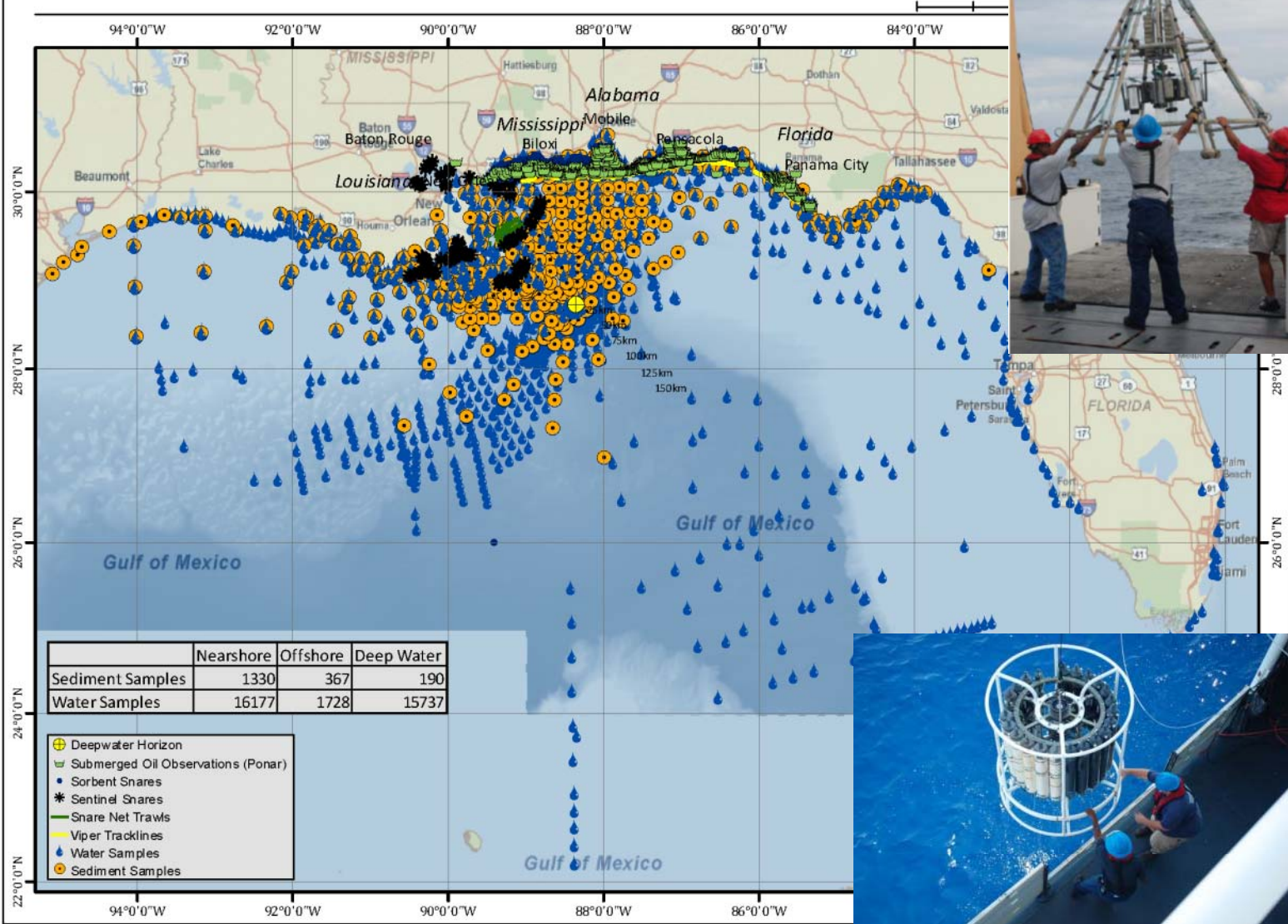
Subsurface Observing Locations for DWH Response



Location of Analyzed (Quantitative) Samples

All Sampling April 28th to October 28, 2010

Deepwater Horizon R

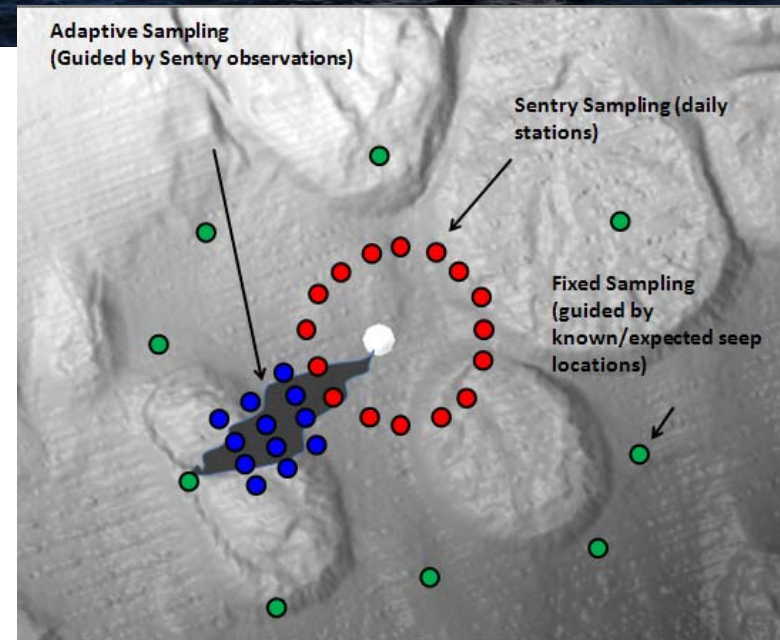


	Nearshore	Offshore	Deep Water
Sediment Samples	1330	367	190
Water Samples	16177	1728	15737

- ⊕ Deepwater Horizon
- ▭ Submerged Oil Observations (Ponar)
- Sorbent Snares
- * Sentinel Snares
- Shore Net Trawls
- Viper Tracklines
- Water Samples
- Sediment Samples

Summary of Effort for SMU

- Over 25 open water vessels
- Over 125 dedicated cruises
- Over 850 days at sea
- Over 31,000 physical samples
- Over 40,000+ ocean obs. sites
- Data types collected:
 - Chemistry
 - Sediments
 - Acoustics
 - Imagery
 - Conditions



- Source control/SIMOPS
- Model output
- Empirical data/statistics
- Understanding dynamics
 - Physical/chemical

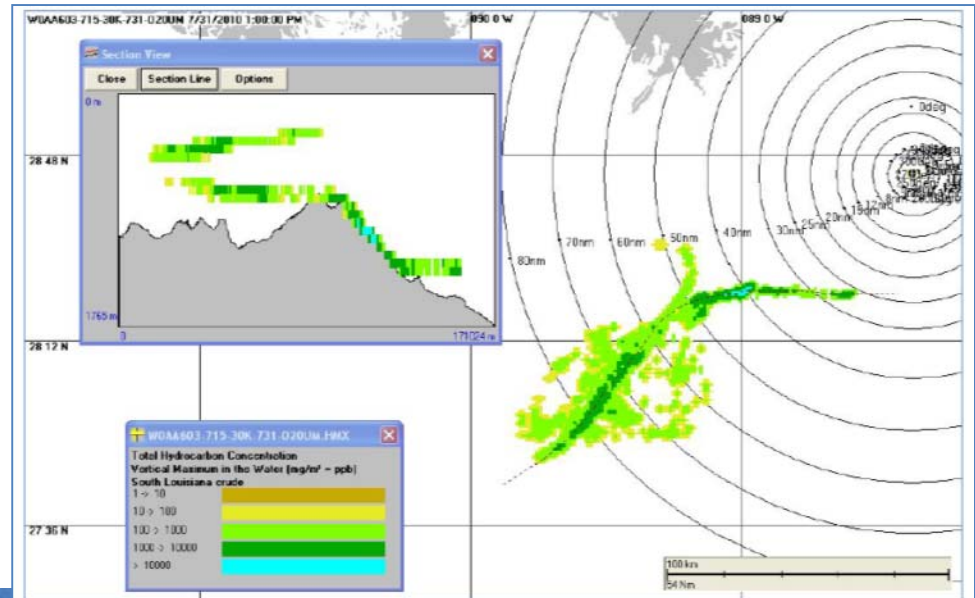
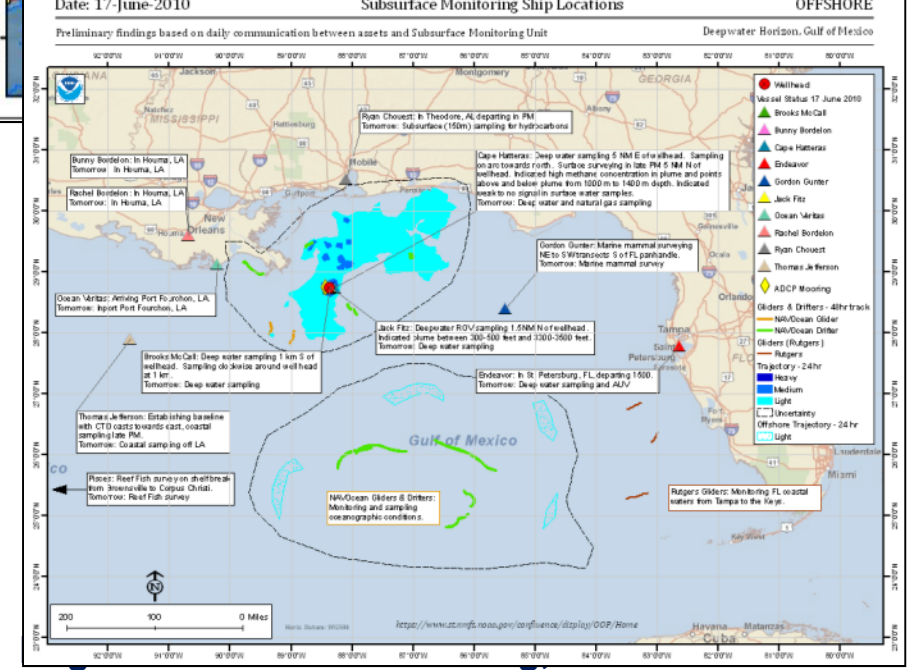
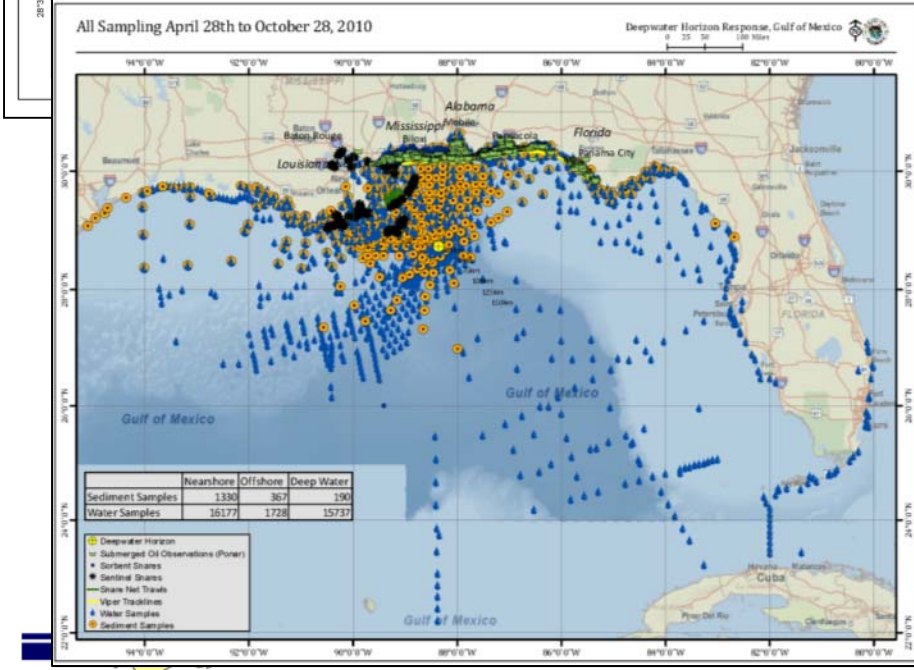
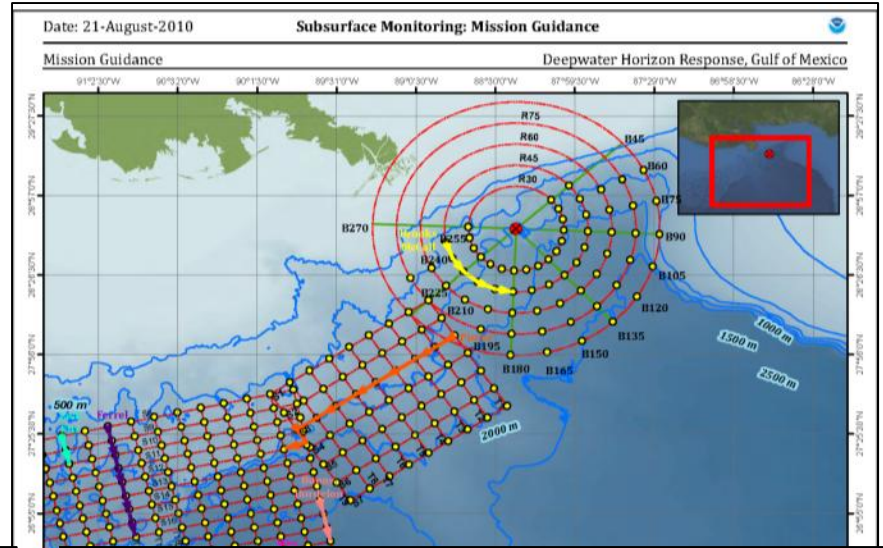
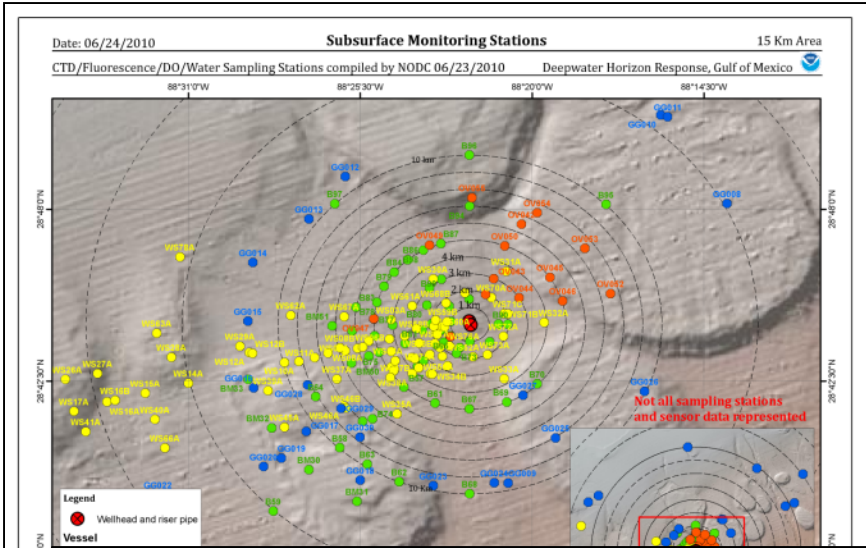


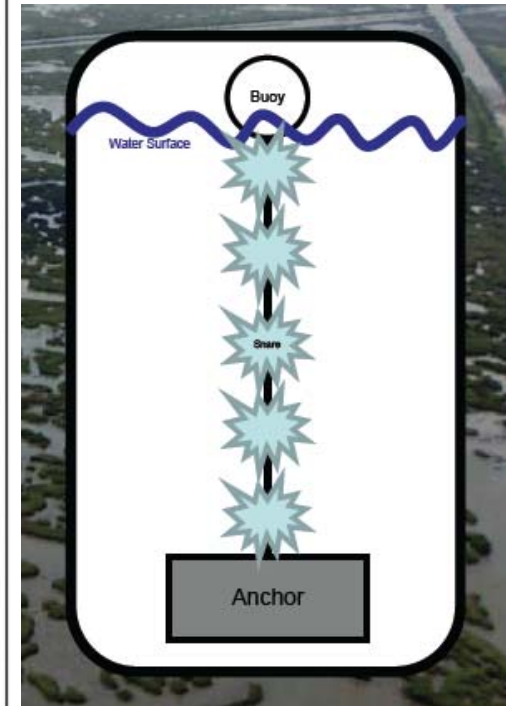
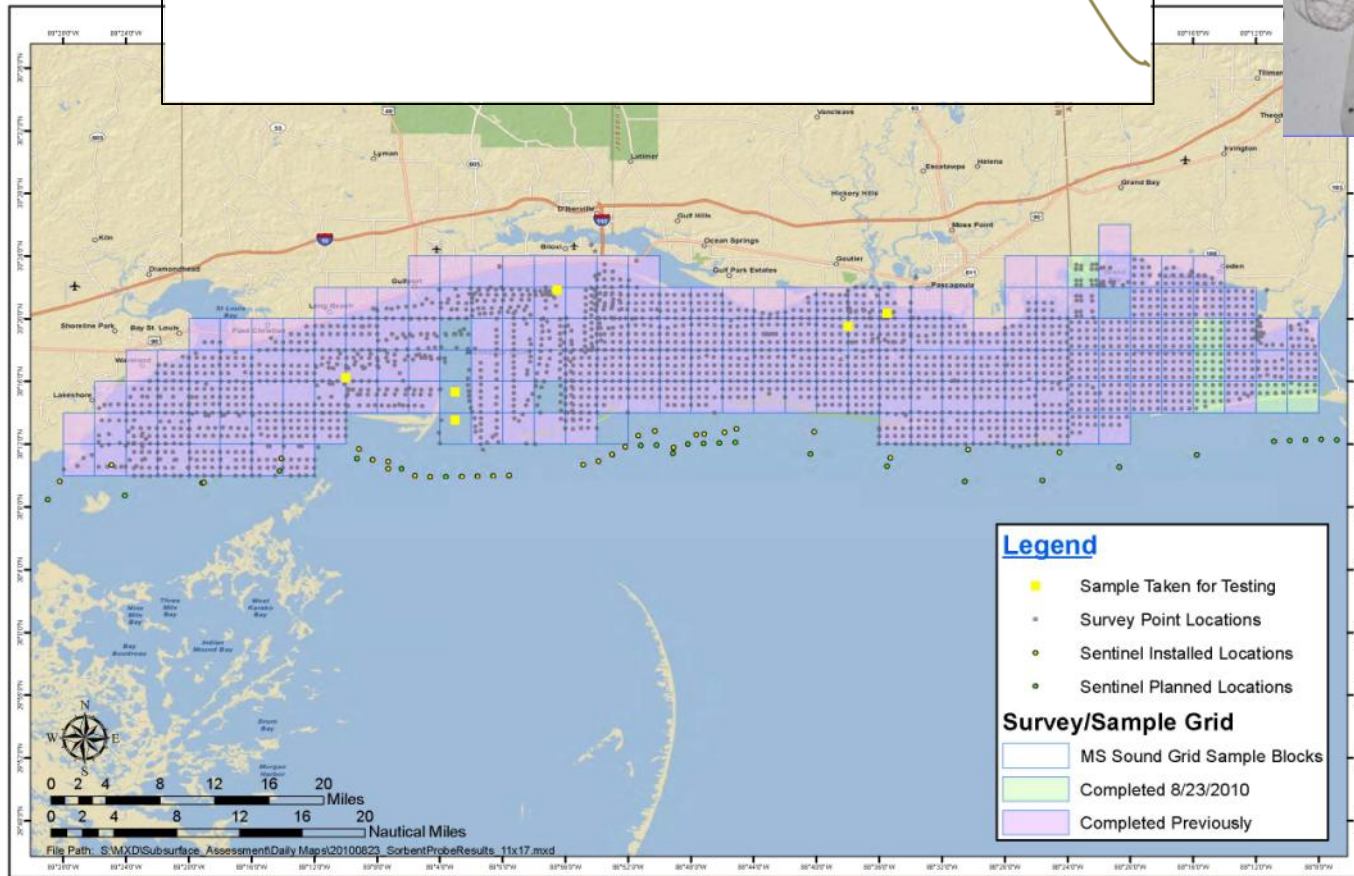
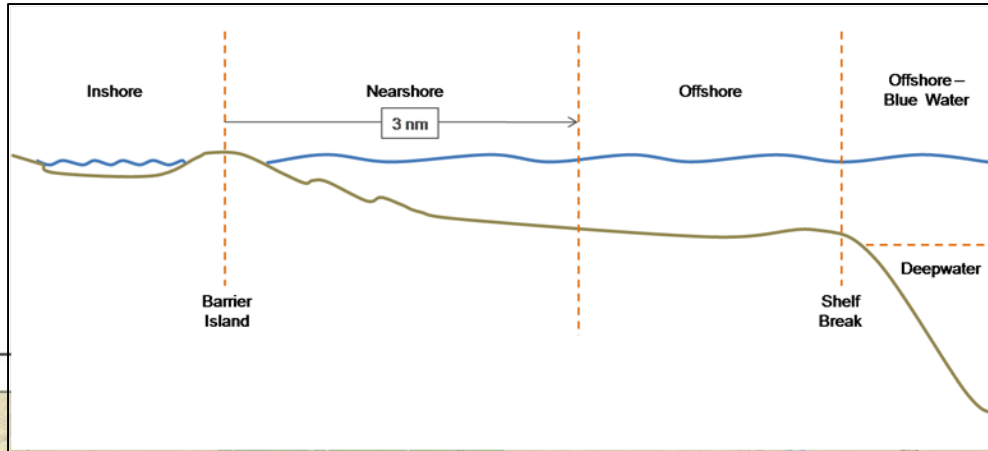
Figure 8. Modeled total hydrocarbon concentrations in oil droplets, assuming all droplets are 20um in diameter (which also tracks movements of dissolved components), for a release from 3 June to 15 July, 2010 – snapshot taken Jul 31, 2010 at 1300 CDT – cross-section from W to E in the center of the plume.



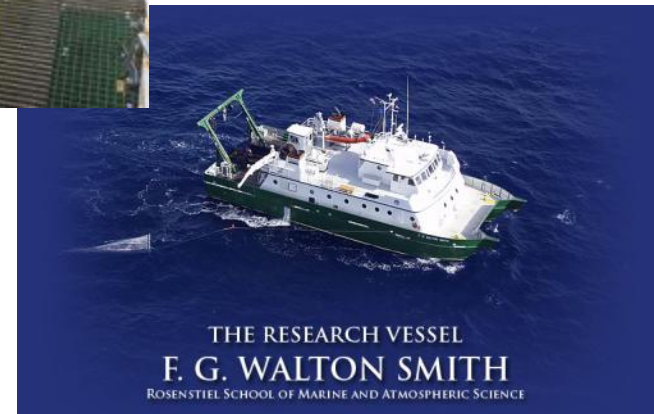
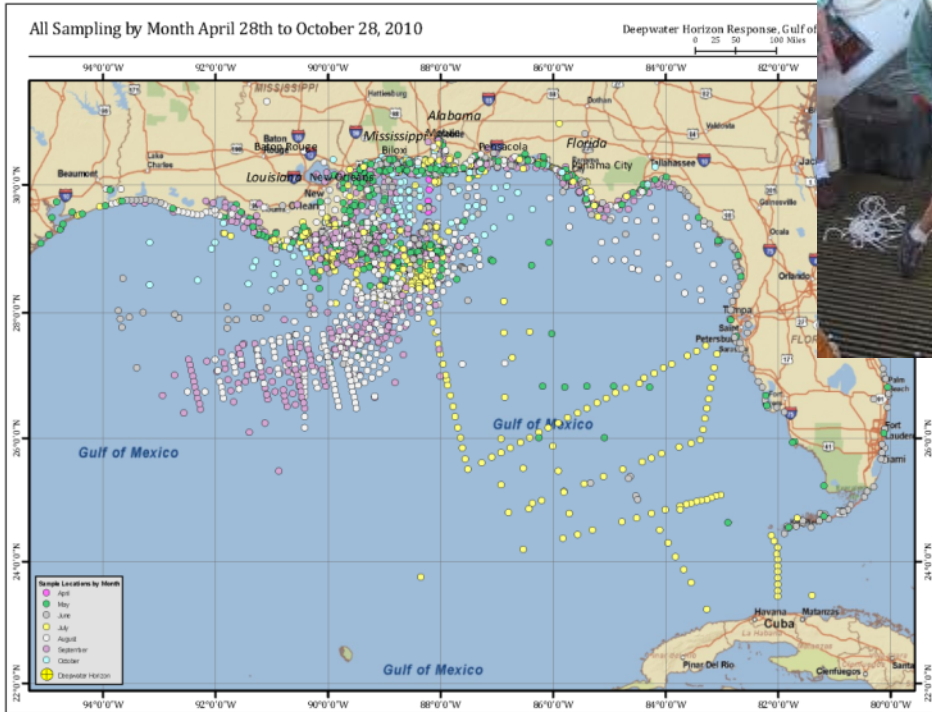
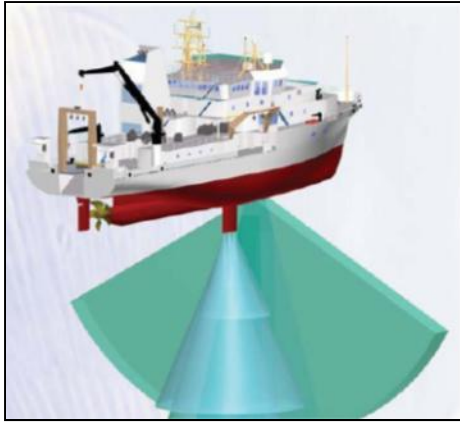
Sub-Surface Operational Products



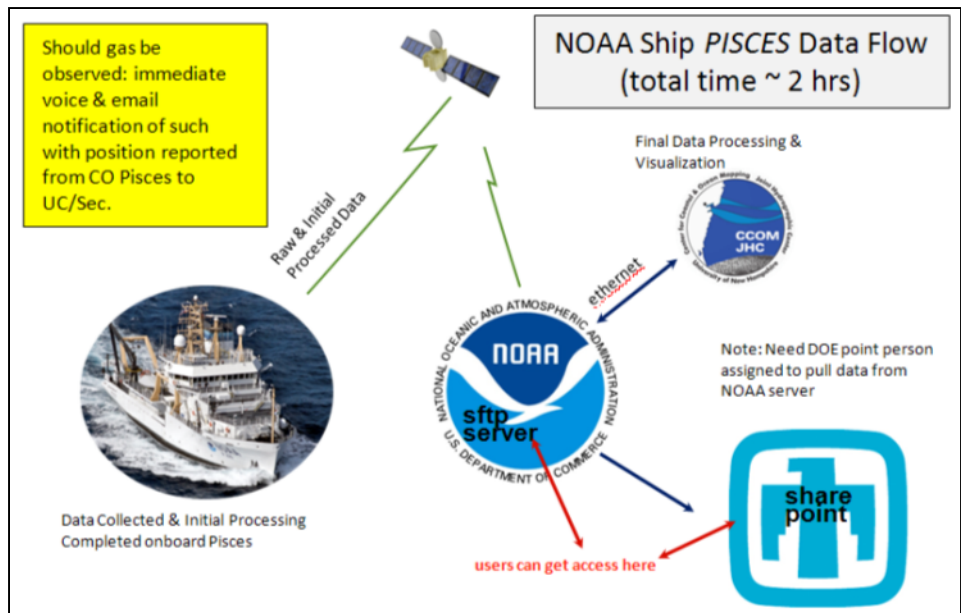
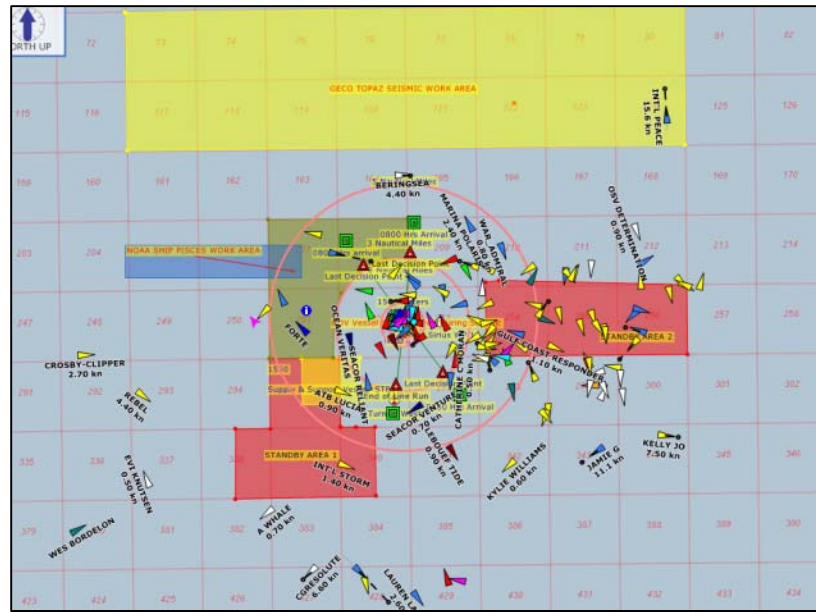
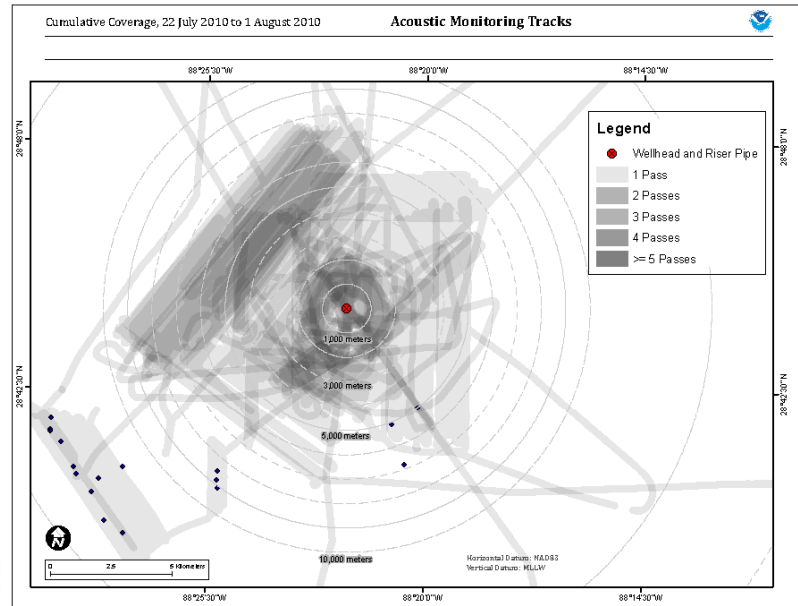
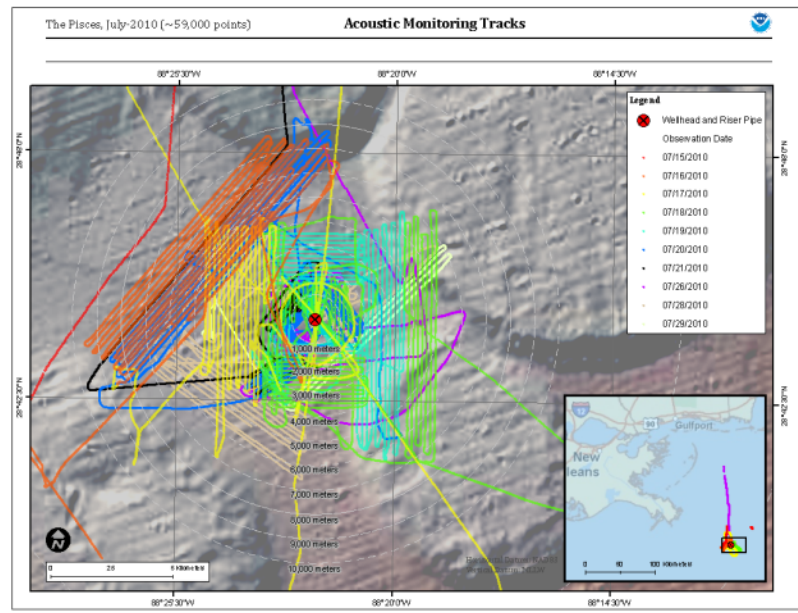
Nearshore Sampling and Technologies



Offshore Sampling and Technologies



Support of Wellhead Integrity Test (WIT)



Benthic and Wave Gliders

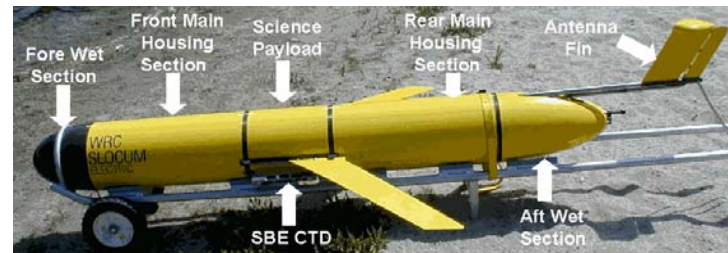
- Autonomous
- High Endurance
- Customized Payloads
- Typical Measurements:
 - temperature
 - salinity
 - currents
 - chlorophyll
 - fluorescence
 - acoustic backscatter
 - dissolved oxygen
 - XYZ, time



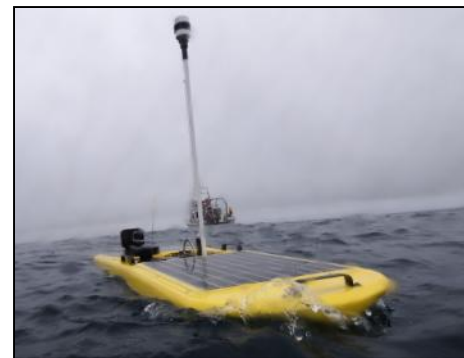
Spray Glider - Scripps



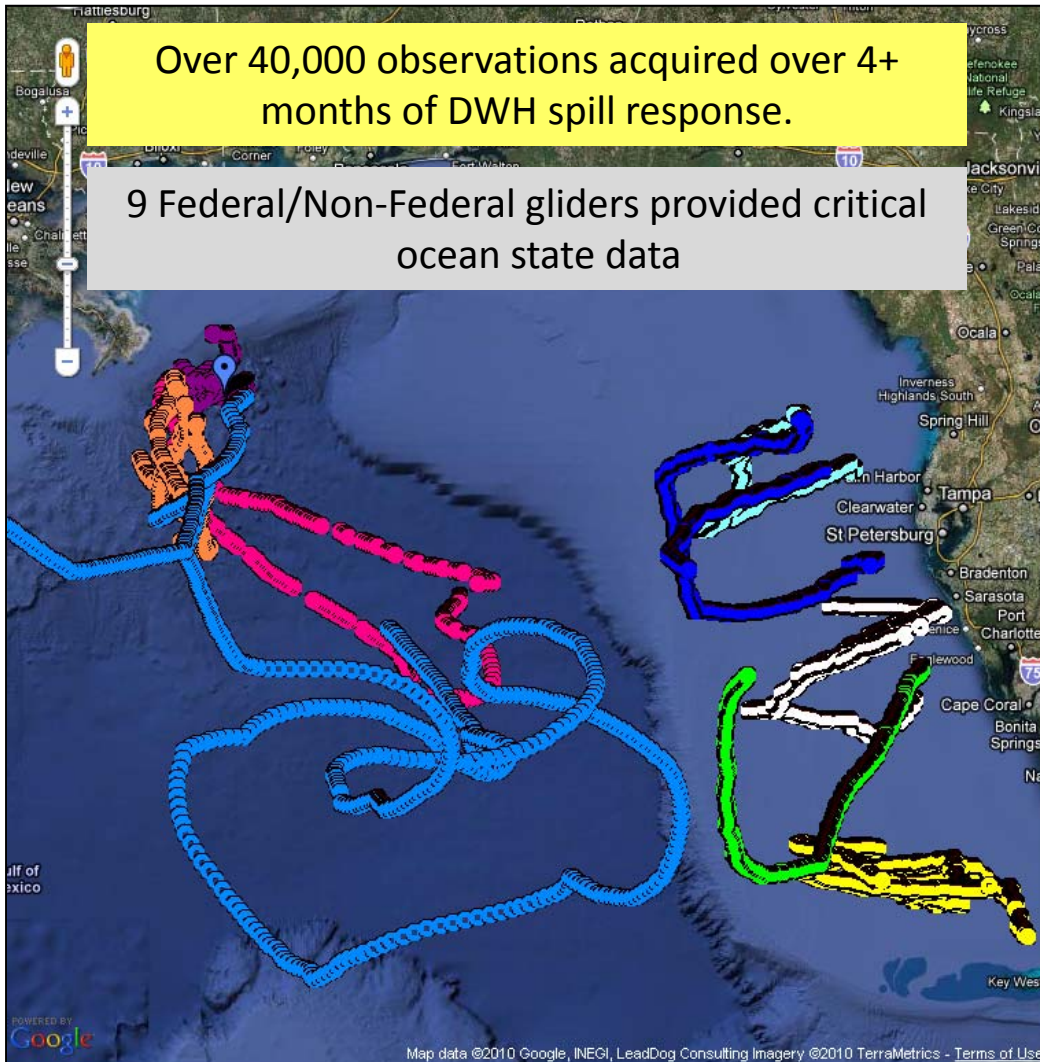
SeaGlider- IRobot®



Slocum Glider – Teledyne Webb Research



Wave Glider - Liquid Robotics®



NATIONAL OCEANOGRAPHIC DATA CENTER (NODC)

[Back to Glider and Float Data](#) | [NODC Home](#)

Glider Data

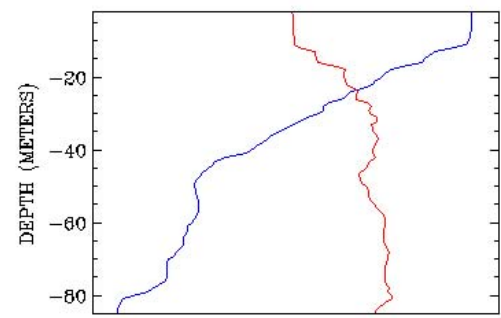
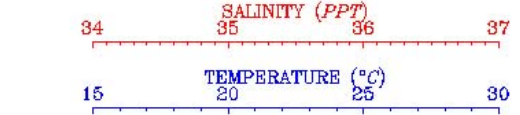
Long load times are possible.
 If all gliders do not appear please refresh the page.
 An underwater glider is a type of autonomous underwater vehicle (AUV) that uses small changes in its buoyancy in conjunction with wings to convert vertical motion to horizontal, and thereby propel itself forward with very low power consumption. This is a Google Maps presentation of oceanographic data stored in the [Global Temperature and Salinity Profile Programme \(GTSP\)](#) database in the vicinity of the BP Deepwater oil spill.

Click any data point to get detailed information about that point.

- Glider 48900
- Glider 48901
- Glider 48902
- Glider 48903
- Glider 48904
- Glider 48905
- Glider 48906
- Glider 48908
- Glider 48909
- Glider 48910

CallSign: 48901
GTSP DBID: 9434472

LAT: 27.788°N **LO:** 84.425°W 2010/05/31 12:50 UTC



NOAA/NESDIS/NODC

<http://www.nodc.noaa.gov/General/DeepwaterHorizon/support.html>

<http://rucool.marine.rutgers.edu/deepwater/>

MBARI Gulper:

- Hybrid AUV-Glider
- Deployed for DWH
- Capable of Sample Capture
- Carries Sensor Payload



MBARI Gulper being deployed from NOAA Ship *Gordon Gunter* in support of Deepwater Horizon response



Initial Sub-Surface Observations



- **Fluorometry and CTD observations are excellent complementary tools**
- **Dissolved oxygen depression (but not hypoxia) observed**
- **Very few measured exceedences of human/ecological thresholds**
- **Subsurface model projections were validated by *in situ* observations**
- **Strong evidence of dispersed oil between 1000m-1400m (at depth)**
- **Particle-sizing is an important technique for determining dispersion path**
- **Ongoing evaluation of acoustic technology (dispersed oil and seeps)**
- **Both direct and indirect sampling/monitoring techniques were useful**
- **Degradation in deepwater environments remains an area for future study**

Sampling Results and Status

Map Date: 27-August-2010

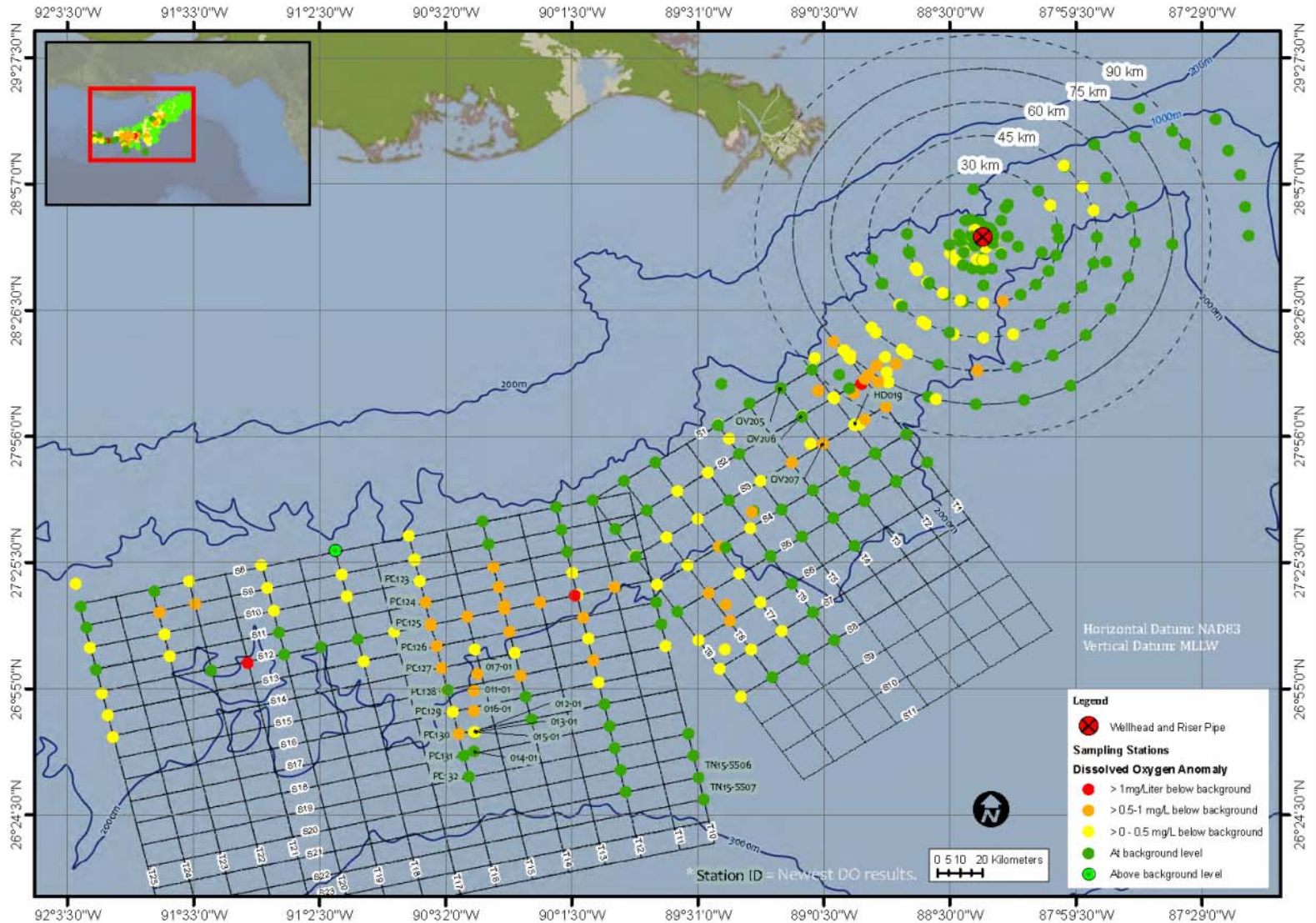
Dissolved Oxygen Results 1000 - 1500 Meter Depths

Mission Guidance

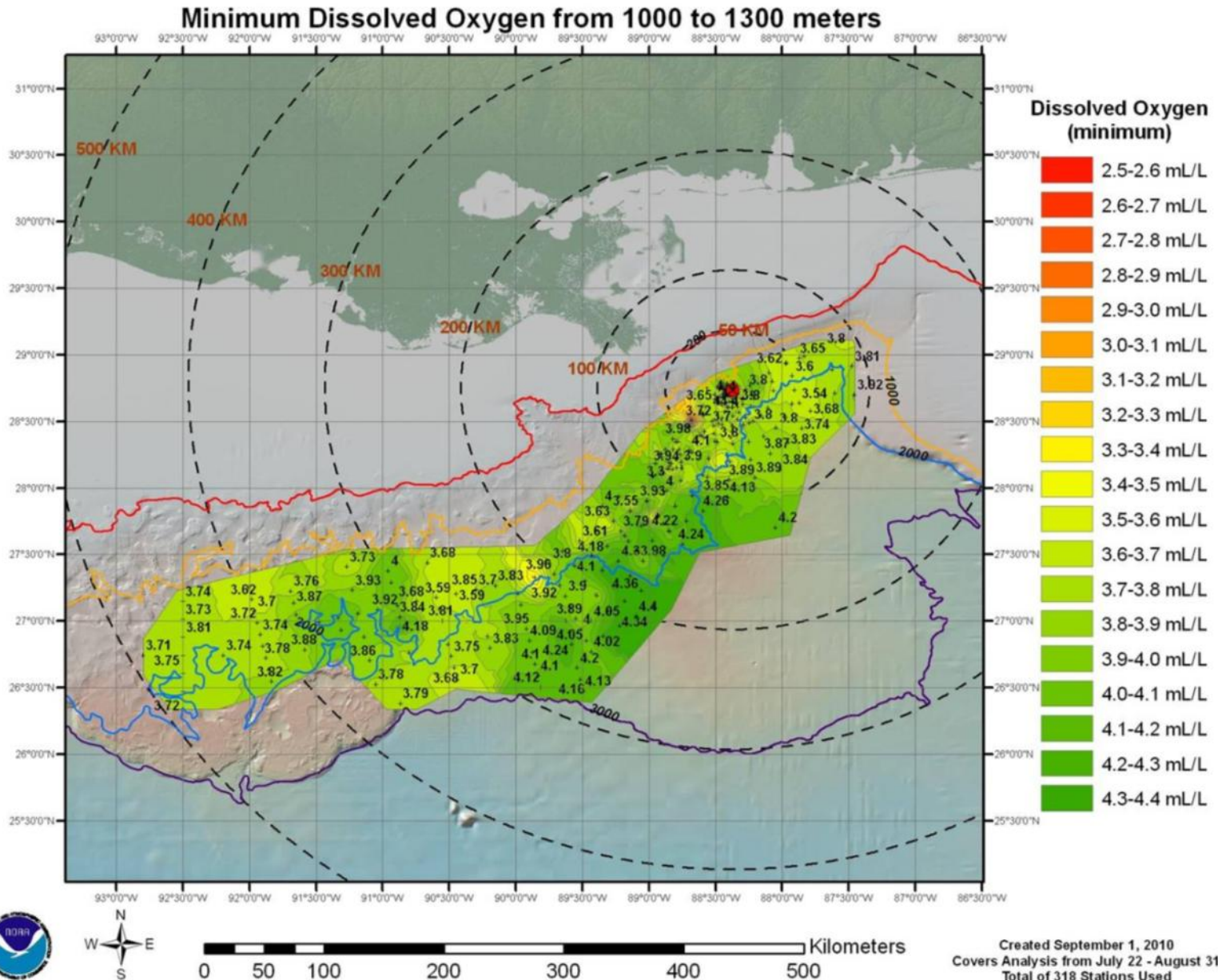


Data Cumulative from 03 Aug to 26 Aug, 2010

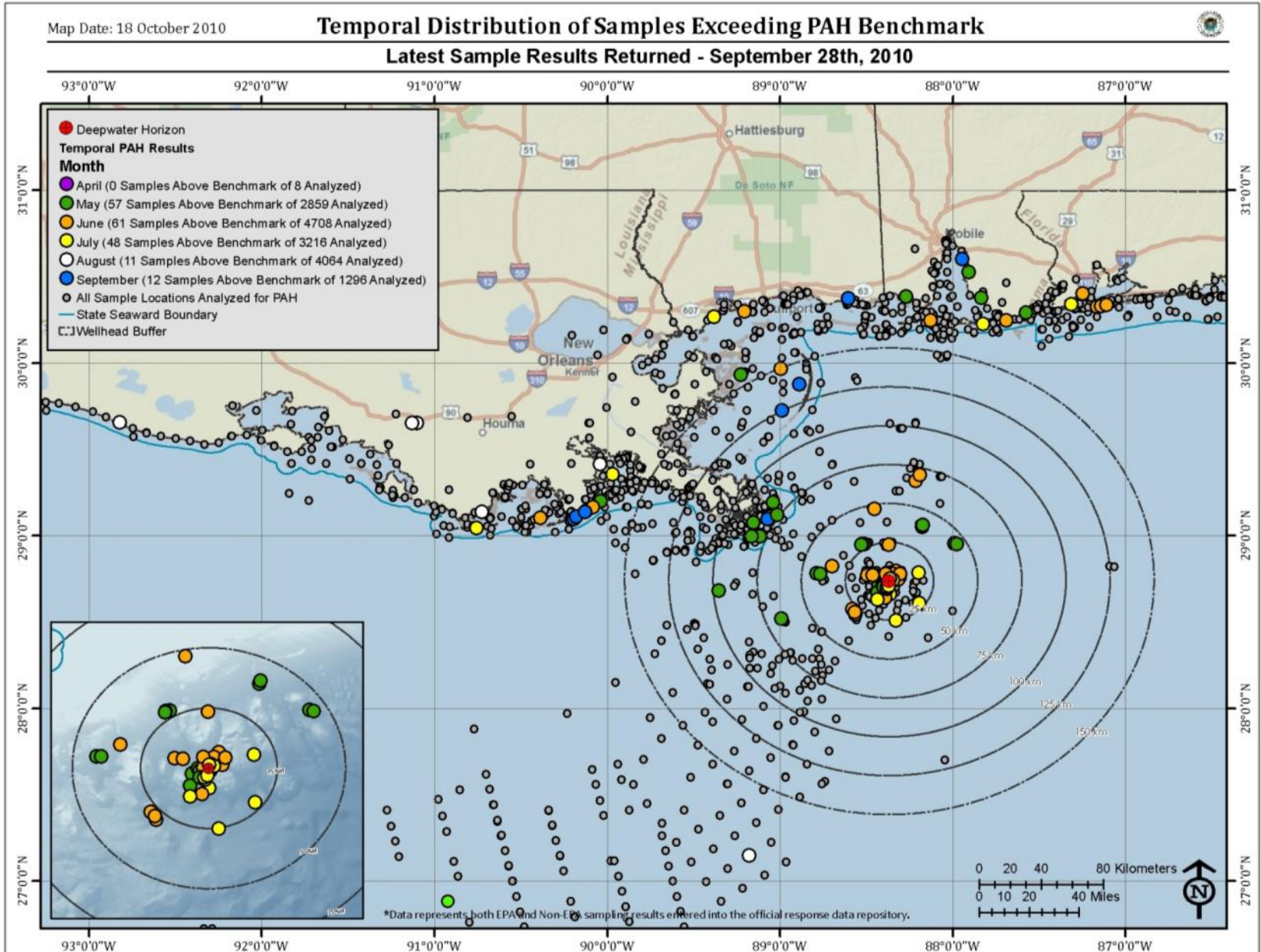
Deepwater Horizon Response, Gulf of Mexico



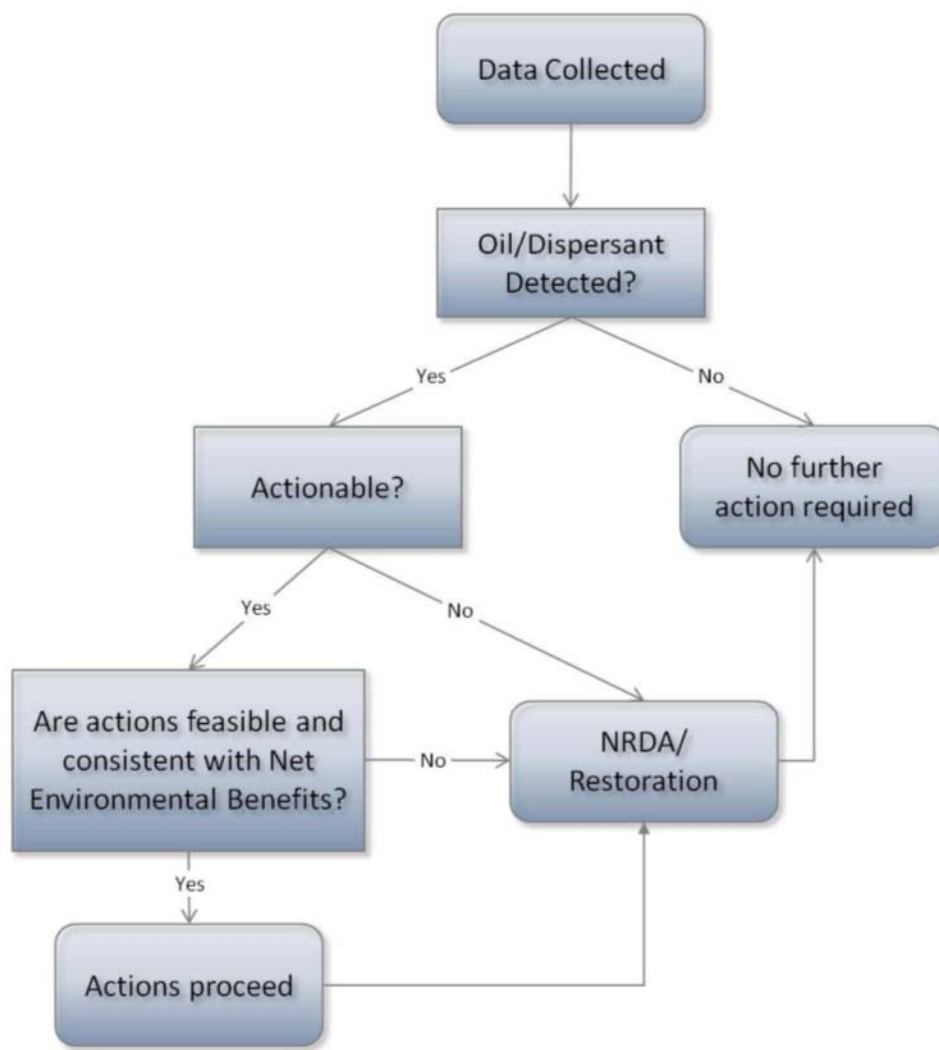
Sampling Results and Status

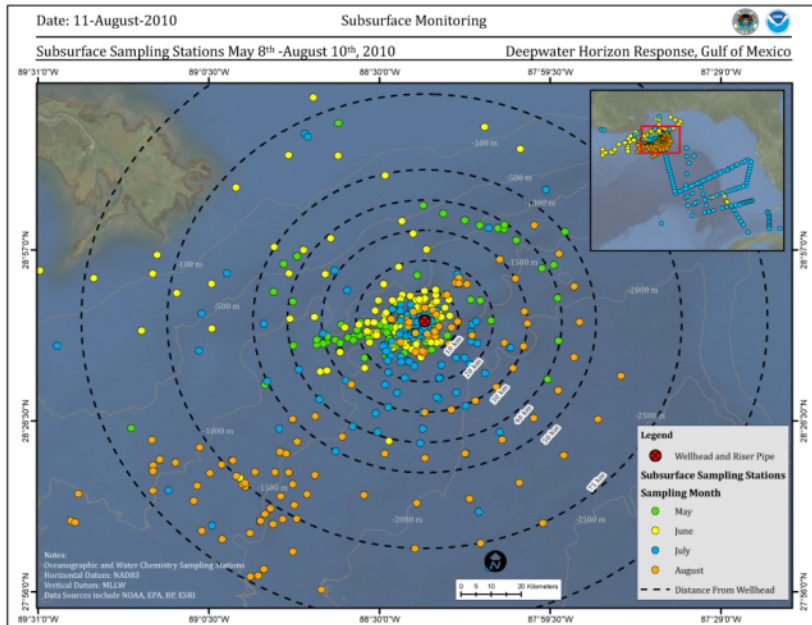
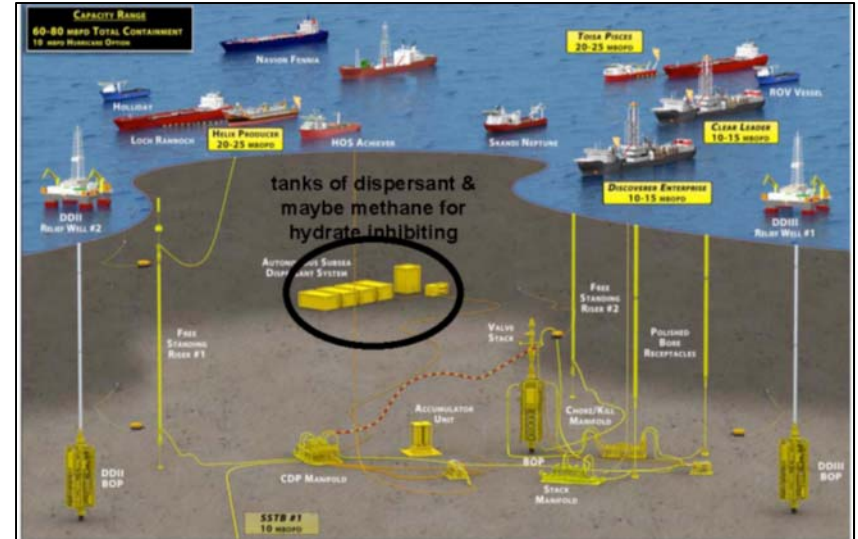


Temporal Distribution of PAH Exceedences



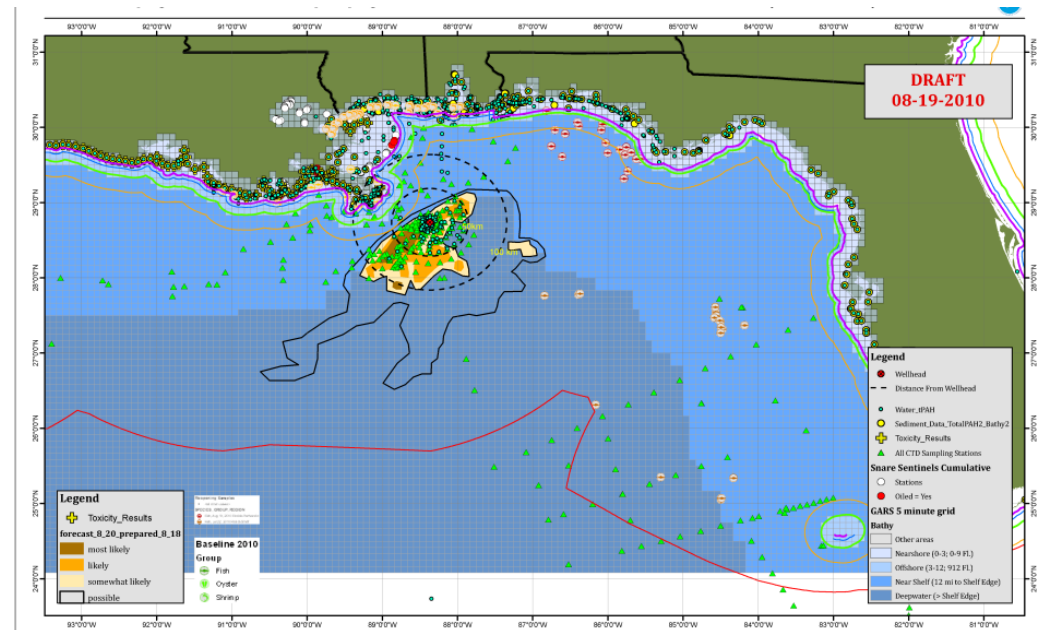
- Primary sampling complete
- Ongoing communications (JAG, OSAT, R4 Mobile reports)
- Comprehensive evaluation
 - Actionable sub-surface oil
 - Human health thresholds
 - Ecological thresholds
- Transition to NRDA teams
- Data Management:
 - Validation efforts
 - Transitioning off-site
 - Exposure and archive





Lessons Learned

- Interagency collaboration was critical to success
- Redundant personnel rotations are optimal
- Modern communications had pros/cons (e.g., wiki)
- Data management is a crucial operational component
- Communicating results was challenging
- Research vs. Response
- Closer tie to modeling teams
- R&D opportunities abound



- Rapid deployment and calibration
- Data integration and visualization
- Sustained ocean observing systems
- Additional acoustic mapping (seeps)
- NRT analysis is needed
 - Dedicated labs
 - In situ GC/MS
- AUVs and Gliders
 - Depth limitations
 - Need for centralized fleet (NAVO)
 - Air/water interface with wave gliders



Data and Information Sources



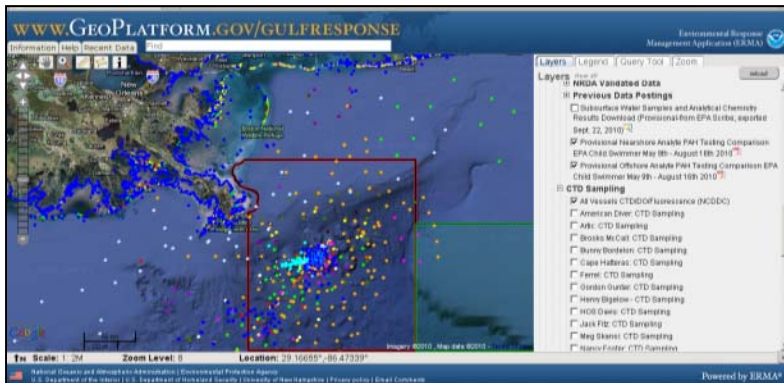
Ocean Observation Data

<http://www.nodc.noaa.gov/General/DeepwaterHorizon/support.html>



Restoration Efforts

<http://www.restorethegulf.gov>



Analytical Chemistry Data and Related DWH Data

<http://www.geoplatform.gov>



Subsurface Monitoring Program Updates

<http://www.restorethegulf.gov/release/2010/10/02/subsurface-oil-monitoring-overview>