Operational Science Advisory Team (OSAT)

UNIFIED AREA COMMAND

Summary Report for Sub-Sea and Sub-Surface Oil and Dispersant Detection:

Sampling and Monitoring

Prepared for

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Federal On-Scene Coordinator

Deepwater Horizon MC252

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U.S. Department of
Homeland Security

United States
Coast Guard

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MEMORANDUM

From: RADM P. F. Zukunft, USCG
Unified Area Command, New Orleans

To: VADM R.C. Parker, USCG
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Subj: OPERATIONAL SCIENCE ADVISORY TEAM REPORT

On 18 August, 2010 I chartered the Operational Scientific Advisory Team (OSAT) to provide me with situational data and analysis for use in directing the on-going response operations. The team developed a strategy to assimilate available data as well as to identify areas where additional sampling was necessary to guide oil removal activities and assess the presence of dispersants. This sub-sea and sub-surface monitoring assessment effort was comprehensive and culminated in a rigorous set of analytical data.

These data sets were gathered and integrated based upon the 13-step Unified Area Command Strategy promulgated on 18 August 2010. The resulting assessment has guided the oil removal phase of the Deepwater Horizon spill response. This report includes assessment of data from tens of thousands of water and sediment samples taken from over 25 different ocean-going research ships on more than 125 separate cruises and representing over 850 ship-days at sea. This report focuses on information needed to guide response actions and does not draw conclusions about the long-term environmental impacts of the spilled oil. Trustee agencies will continue to study the impacts of this oil spill on the Gulf of Mexico and make assessments under other authorities. The sampling and assessment data in this OSAT report are available to support restoration and research objectives including, but not limited to, the Natural Resource Damage Assessment.

As described in the National Incident Commander's Directive of 13 August, 2010 and the Sub-Sea and Sub-Surface Monitoring Strategy dated 18 August, 2010, the goals of this data collection and analysis were to:

a. Monitor and assess the distribution, concentration, and degradation of the portion of the oil that remains in the water column and/or bottom sediments;
b. Evaluate the distribution of indicators of dispersant or break-down products of dispersants used in oil spill response activities;
c. Identify any additional response requirements that may be necessary to address any remaining sub-surface oil.

In leading the largest pollution response effort in United States history, I established decision points on which to base oil removal actions. These decision points were tied to the following indicators:

a. The presence of oil and/or dispersants. Indicators to evaluate the presence and extent of oil and/or dispersants were established for each zone.

   (1) In nearshore waters, indicators included comparisons of oil and dispersant concentrations to human health and aquatic life benchmarks, fishery closures, and qualitative indications of oil presence. In nearshore sediments, indicators included results of toxicity testing and comparisons to reference locations and pre-impact sampling.
   (2) In the offshore waters, water quality was evaluated using human health and aquatic life benchmarks and fishery closures. Offshore sediment oil and dispersant concentrations were evaluated using aquatic life benchmarks and comparisons to reference locations and pre-impact sampling.
   (3) In the deep water environments, the indicators included dissolved oxygen concentrations, comparisons to aquatic life benchmarks, and fishery closures. In deep water sediments, indicators included comparisons to aquatic life benchmarks and comparisons to sampling at reference locations.

   These indicators were chosen as the basis for the most aggressive oil and dispersant removal activities possible to return the impacted environment to pre-spill condition. Toxicity studies on water and sediment samples were conducted, and will be the subject of a separate toxicity addendum to this report which will be released in early 2011.

b. Whether oil and/or dispersants are "actionable"

   OPA 90 defines a removal action as "containment and removal of oil or a hazardous substance from water and shorelines or the taking of other actions as may be necessary to minimize or mitigate damage to the public health or welfare, including, but not limited to, fish, shellfish, wildlife and public and private property, shorelines and beaches."

c. Whether oil removal actions are feasible and consistent with net environmental benefit.

   (1) The recovery/removal/treatment action does not present an undue safety risk to response personnel.

   (2) The recovery/removal/treatment actions will not cause or increase injury to adjacent habitat or resources.

   (3) The recovery/removal/treatment action will decrease the recovery time of the threatened resource or habitat over natural attenuation of the contaminant.

Based on the robust sampling effort, the expert analysis of the data provided in this report and the decision criteria summarized above, I have determined that there is no actionable oil in the water or sediments of the deep water or offshore zones. Ongoing removal operations will continue where oil remains in nearshore sediments and shorelines.

The Coast Guard was fortunate to have had enormous assistance in this effort from public and private scientists representing the National Oceanic and Atmospheric Administration, the United States Geological Survey, the Bureau of Ocean Energy Management Regulation and Enforcement, United States Fish and Wildlife Service, the Environmental Protection Agency and numerous academic and oceanographic research institutes and chemical laboratories.

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Executive Summary

The purpose of this report is to provide the Federal On-Scene Coordinator for the Deepwater Horizon MC252 Spill of National Significance with sufficient information to determine the presence or absence of sub-surface oil and dispersants amenable to removal actions[1] *under the provisions of the Clean Water Act, the Oil Pollution Act of 1990, and the National Oil and Hazardous Substances Pollution Contingency Plan*.

Response to the Deepwater Horizon MC252 Spill of National Significance (DWH oil spill) resulted in an unprecedented amount of sampling in Gulf of Mexico waters by multiple federal, state, and academic entities, as well as by BP (a responsible party). To transition sub-surface monitoring out of the response phase of the oil spill, the National Incident Commander (NIC) directed that the Unified Area Command (UAC) develop a comprehensive plan to implement the detection, sampling, and monitoring strategy for sub-surface oil and dispersants, as a removal action in accordance with the Clean Water Act.

The subsequent UAC plans in response to this directive established specific factors to be considered by the Federal On-Scene Coordinator (FOSC) in making the determination about when to transition offshore activities from the emergency response phase to the long term recovery and restoration phase. This decision will be based on: (1) monitoring and assessing the distribution and degradation of the portion of oil that remains in the water column, (2) evaluating the distribution of dispersant indicators used in oil spill response activities, and (3) identifying any additional response requirements that may be necessary to address remaining sub-surface oil.

The Operational Science Advisory Team (OSAT) was formed by the UAC as a small, interagency team (see Appendix H) to assess near real-time data collected by the response relative to specific indicators and to identify sampling gaps as part of an adaptive sampling strategy. This report provides an assessment of the distribution of actionable (i.e. amenable to removal actions) oil and dispersant-related chemicals that remain in the water column and/or bottom sediments and provides a summary of sampling results to inform decision makers on further oil removal operations. Where appropriate, the report also includes results from independent scientific investigations into the DWH oil spill. Assessing non-response questions, including quantitative estimates of remaining oil and the long-term environmental impacts of the DWH oil spill, are beyond the scope of this report. Additional monitoring and assessment efforts will be conducted in accordance with Natural Resources Damage Assessment (NRDA) processes.

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[1] The Oil Pollution Act of 1990 (OPA 90) defines a removal action as "containment and removal of oil or a hazardous substance from water and shorelines or the taking of other actions as may be necessary to minimize or mitigate damage to the public health or welfare, including, but not limited to, fish, shellfish, wildlife, and public and private property, shorelines and beaches."

Specific Report Indicators

The following specific indicators were established by the UAC to define the presence or absence of potentially actionable oil:

- Qualitative observations of oil.
- Environmental risks associated with oil-related organic compounds.
- Human health risks from exposure to oil-contaminated water.
- Environmental risks related to dispersant component chemicals.
- Fishery closures.
- Toxicity to benthic invertebrates.
- Comparison of analytical chemistry measurements to reference stations and measurements from earlier in the year.
- Indicators of hypoxia in deep water seaward of the continental shelf.

A discussion of uncertainties associated with applying these indicators across the entire response dataset is presented in relevant sections throughout the document and is described in detail in Appendix C.

Key Findings

1. No deposits of liquid-phase[1] MC252 oil were identified in sediments beyond the shoreline.

2. No exceedances of EPA's Human Health benchmark were observed.

3. No exceedances of EPA's dispersant benchmarks were observed.

4. Since 3 August 2010, <1% of water samples and ~1% of sediment samples exceeded EPA's Aquatic Life benchmarks for polycyclic aromatic hydrocarbons (PAHs). Analysis of individual samples indicated that none of the water sample exceedances were consistent with MC252. Of the sediment exceedances, only those within 3 km of the wellhead were consistent with MC252.

5. Published research indicates that MC252 oil is weathering and biodegrading under natural conditions. Estimates of weathering and degradation rates vary, precluding the use of simple empirical models to assess the persistence of residual MC252 oil.

6. Of the previously closed fisheries, 87,481 mi^2 (state and federal) have been reopened; 1041 mi^2 around the wellhead remain closed. In addition, 4,213 mi^2 were closed to royal red shrimping on 24 November.

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[1] The presence of liquid-phase oil is highlighted here (as contrasted to oil in the form of tar mats or sediment-entrained oil) for its relevance to decisions regarding recovering oil from the environment

7. Quantitative results indicate that deposits of drilling mud-entrained oil remain near the wellhead. Seven sediment samples within 3 km of the wellhead collected since 3 August 2010 exceed aquatic life benchmarks for PAHs, with oil concentrations of 2000-5000 parts per million.

8. The study of tar mats in shallow nearshore waters was identified as a sampling gap. The sampling methods previously used did not sufficiently address tar mats. A focused group (OSAT II) has been chartered by the UAC to address this issue.

Based on the analysis of extensive data collected in the nearshore, offshore, and deep-water zones, the OSAT concludes that sampling was adequate to address the presence or absence of sub-surface oil and dispersants (with the exception of the nearshore sampling gap identified in Key Finding 8 above).

Based on the data collected as part of this sampling effort, the OSAT identified sediments within 3 km of the wellhead as one area of concern with respect to the chronic Aquatic Life Benchmarks considered. Some sediment locations near the wellhead have concentrations of oil-related compounds that exceed the aquatic life benchmark, as well as associated quantities of drilling mud, likely from source control efforts. The decision on whether or not this oil is actionable lies with the FOSC. Long-term chronic effects to the benthic environment are being assessed as part of the injury assessment conducted through the Natural Resources Damage Assessment (NRDA) process.

Observations from qualitative programs in the nearshore sampling zone indicate tar mats are present in some sub-tidal nearshore areas. These subsurface tar mats could potentially be remobilized and become a source of shoreline re-oiling. Due to logistical constraints associated with sampling in the shallow nearshore zone, the sub-surface sampling plans did not entirely address this region. Current efforts to address this issue within the UAC include continued monitoring by shoreline assessment teams and the formation of a specialized group at the UAC (OSAT II) to evaluate existing data and make recommendations for any additional sampling.

Table of Contents

Section 1: Introduction

The purpose of this report is to provide the FOSC with sufficient information to determine the presence or absence of sub-surface oil and dispersants amenable to removal actions[1] *under the provisions of the Clean Water Act, the Oil Pollution Act of 1990, and the National Oil and Hazardous Substances Pollution Contingency Plan*.

During the Deepwater Horizon MC252 Spill of National Significance (DWH oil spill), oil and gas were discharged from the wellhead approximately 5,000 feet below the sea surface for 87 days until the well was successfully capped on 15 July 2010[2]. The last overflight observation of potentially recoverable oil on the ocean surface was made on 3 August. However, both naturally occurring physical processes and the use of dispersants as a response option led to substantial quantities of dissolved and dispersed oil in the sub-surface environment of the Gulf of Mexico ("sub-surface" refers in this report to both the water column and the bottom sediments). Of the total volume spilled,[3] approximately 1.4 million barrels were estimated to be naturally (630 k bbl) or chemically (770 k bbl) dispersed, the majority of that amount at the wellhead[4] (U.S. Coast Guard et al., 2010). During the DWH oil spill response, a total of 1.84 million gallons of dispersants were applied both at the surface (1.06 million gallons, primarily COREXIT 9500A and some 9527) and directly at the wellhead on the seafloor (0.78 million gallons COREXIT 9500A) during the DWH oil spill response (National Commission, 2010b). This sub-surface oil and the dispersant compounds presented potential public health and ecological concerns.

Beginning in early May, sampling and monitoring operations were conducted in both surface and sub-surface environments of the Gulf of Mexico to locate any oil and/or dispersant-related chemicals from the DWH oil spill and the associated response. A multitude of state and federal agencies performed pre-impact (the period between the rig explosion and shoreline oiling) sampling and numerous extensive sampling programs continued throughout the response.

On 3 August, the National Incident Commander (NIC) directed that the Unified Area Command (UAC) develop a comprehensive sampling plan to assess the presence of actionable sub-surface oil and dispersant-related chemicals remaining in the environment (hereafter referred to as the NIC directive). In response, the Unified Area Command (UAC) implemented the largest sampling and monitoring program ever conducted during an oil-

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[1] The Oil Pollution Act of 1990 (OPA 90) defines a removal action as "containment and removal of oil or a hazardous substance from water and shorelines or the taking of other actions as may be necessary to minimize or mitigate damage to the public health or welfare, including, but not limited to, fish, shellfish, wildlife, and public and private property, shorelines and beaches." See The Implementation Plan, Section 3 for a more complete description of a removal action.

[2] All subsequent dates in this report are 2010 unless otherwise noted.

[3] The National Incident Command Flow Rate Technical Group estimated that 4.93 million barrels of oil ±10% were released from the well.

[4] Deepwater Horizon MC252 Gulf Incident Oil Budget Government Estimates through August 1, 2010 (Day 104) were generated using an application operated by the USCG and provided by the USGS in cooperation with the NOAA; see USCG, USGS and NOAA (2010).

spill response. The details of that program were initially set forth by the Federal On-Scene Coordinator (FOSC) in "The Implementation Plan for Sub-Sea and Sub-surface Oil and Dispersant Detection, Sampling and Monitoring," 13 September, hereafter referred to as the Implementation Plan (UAC, 2010a). This direction was further superseded by the Operational Annex for Execution and Management of Sub-Sea and Sub-Surface Detection, Sampling, and Monitoring Missions, 1 October, hereafter referred to as the Operational Annex (UAC, 2010b) and the 13 November Strategic Plan For Sub-Sea and Sub-Surface Oil And Dispersant Detection, Sampling, and Monitoring, hereafter referred to as the Strategic Plan (UAC, 2010c). These documents provide critical context to evaluate the data presented in this report. They describe (1) the overall sampling plan and rationale, (2) procedures to enable adaptive additional sampling, (3) approaches to sharing of data, and (4) the role of the Operational Science Advisory Team (OSAT) in the implementation of the sampling plan and production of this report.

During the course of the response, over 17,000 samples were collected for the purpose of environmental review (numerous other samples were collected for a diverse spectrum of applications, including waste characterization, forensic analysis etc.). Sampling and monitoring efforts initiated prior to 3 August 2010 were conducted to inform a number of response decisions. After the NIC directive of 3 August (which approximately coincided with the last visual observations of oil on the ocean surface), the response initiated a comprehensive sampling and monitoring program to locate and identify potentially actionable oil in the sub-surface environment. The transport of oil in the environment can result in highly patchy patterns of deposition to the seafloor. The sampling and monitoring program detailed in the Implementation Plan and the Annex was designed with this in mind using a statistically based approach where practicable for nearshore and offshore areas. The final samples in that program were collected on 23 October. Analytical chemistry and toxicity test results collected by multiple agencies throughout the response were published to Scribe, a data management tool developed by the US Environmental Protection Agency (EPA) for managing environmental data (Appendix B.1). The analytical chemistry data used in this report were retrieved from Scribe on 6 December. Complete results from toxicity tests conducted as part of this response were not available when this report was written. A complete report on toxicity tests will be published at a later date as an addendum to this report. The NOAA National Oceanographic Data Center (NODC) served as the official database and archive for oceanographic data (Appendices B.2, B.6). Data management protocols were established by the Sub-surface Monitoring Unit (SMU) or the data originator (Appendices B.3-B.6).

In mid-August, the Operational Science Advisory Team (OSAT) was formed by the UAC as a small, interagency team to assess near real-time data collected by the response and to identify sampling gaps as part of an adaptive sampling strategy. The team was tasked with making timely recommendations to inform response decisions. Therefore, OSAT recommendations (and this report) include some data that is still being finalized and validated. In addition, in attempting to include all analytical data collected by numerous agencies during the response, inconsistencies in methodologies and data reporting led to numerous issues (not all of which were entirely resolved at the time of this report; see Appendix C). These inconsistencies do not affect the overall conclusions of this report.

However, the underlying dataset should be considered preliminary and subject to future modification.

The OSAT reviewed 1) the results of the sampling and monitoring efforts conducted by the response to monitor sub-surface oil and dispersants, 2) observations from activities designed to inform other response decisions (e.g. Shoreline Cleanup Assessment Teams [SCAT]), 3) available reference data from sampling programs in existence before the DWH oil spill, and 4) results provided by independent researchers within the academic community. These data were reviewed by the OSAT in order to:

- Inform and guide the adaptive nature of the Implementation Plan (Appendix E.4).
- Make recommendations for filling sampling gaps.
- Compare results to specified indicators.
- Provide an assessment regarding the presence of oil and/or dispersants related chemicals.

This report summarizes the key data reviewed and presents the recommendations and supporting analyses provided by the OSAT to the FOSC.

The indicators used in this report were chosen specifically to assess the presence of oil and dispersant-related compounds and not for assessing long-term ecological impacts in all sub-surface environments. A significant amount of additional work will be necessary to fully evaluate the acute and chronic impacts of this incident. These investigations are currently underway as part of the Natural Resource Damage Assessment (NRDA) process. BP has also established the Gulf Coast Restoration Organization (GCRO) to manage long term response and restoration activities and the Gulf Research Institute (GRI), which will fund independent research to study the impact of the incident on the environment and/or public health in the Gulf of Mexico.

Section 2: Explanation of Indicators

The Strategic Plan established a suite of sediment and water-quality indicators to determine whether or not oil and/or dispersant-related chemicals have been "detected." These indicators (see Table 2.1) were designed to assess impacts on public health and aquatic life in the immediate context of a removal action. The benchmarks utilized are intended to identify conditions that may pose an immediate threat to the environment; adverse effects (sub-lethal and long-term) could also occur at concentrations lower than these benchmarks.

Table 2.1. Indicators used in the evaluation of sub-surface sampling data (after Table 3.1, The Strategic Plan).

INDICATORS Observations and measurements will be compared to:			
	Nearshore (shoreline to 3 nmi)	**Offshore** (3 nmi to 200 m depth)	**Deep-water** (beyond 200-m depth)
Water	1. Public Health Taskforce Human Health Benchmark for Child Swimmer 2. Fishery closures 3. Observations using qualitative methods (VIPERS,[1] snares, sorbent pads) 4. EPA acute and chronic aquatic benchmarks for PAHs[2] 5. Aquatic benchmarks for dispersant compounds	1. EPA acute and chronic aquatic benchmarks for PAHs 2. Fishery closures 3. Aquatic benchmarks for dispersant compounds	1. Indicators of hypoxia (dissolved oxygen concentration of ≤2.0 mg/L) 2. Fishery closures 3. EPA acute and chronic aquatic benchmarks for PAHs
Sediment	1. EPA acute and chronic sediment benchmarks for PAHs 2. Observations using qualitative methods (ponar grabs) 3. Significant toxicity to benthic invertebrates 4. Concentrations measured at the same station earlier in the year 5. Average concentrations at reference stations	1. EPA acute and chronic sediment benchmarks for PAHs 2. Average concentrations at reference stations	1. EPA acute and chronic sediment benchmarks for PAHs 2. Average concentrations at reference stations

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[1] Vessels with Petroleum Ensnaring and Recovery Systems

[2] polycyclic aromatic hydrocarbons

These indicators do not represent injuries to natural resources under NRDA authorities in Oil Pollution Act of 1990 (OPA 90), which may occur at lower concentrations. The natural resource damage assessment will evaluate the nature and extent of injuries from the DWH oil spill and is still in the process of collecting and analyzing relevant data for this purpose.

The areas of the Gulf of Mexico affected by this incident were divided geographically into three zones, and each zone has specific indicators (Map 7.1). In general, sampling locations from the shoreline out to 3 nautical miles (nmi) are grouped as the "nearshore" sampling zone. Sampling locations between 3 nmi offshore and the 200 m bathymetry contour are grouped as the "offshore" zone. Sampling locations seaward of the 200 m bathymetric contour are grouped as the "deep-water" zone. However, there were some nearshore sampling programs that included stations seaward of the 3 nmi state waters boundary (the state waters boundary is 9 nmi offshore in Florida). These stations are considered as part of the nearshore sampling zone.

Comparisons of sub-surface data to indicators in this report consider both the entire sampling period (from early May onward) and the period after 3August alone; i.e. the date of the NIC directive to assess remaining sub-surface oil and dispersant compounds in the environment. This date also coincides with the last observations of surface oil by trained aerial observers. Surface oil observed after 3 August is presumed to be due to remobilization of stranded oil or from a source other than MC252.

2.1 Fisheries Closures

During the DWH oil spill, concerns over seafood contamination from oil and dispersant compounds led to a closure of over 88,500 mi^2 in the Gulf of Mexico to fishing on 2 June 2010 (National Marine Fisheries Service [NMFS], 2010). The UAC determined that the status of these fisheries closures was one of the indicators to be used in the evaluation of sub-surface sampling data.

2.2 Concentrations Measured at the Same Station Earlier in the Year

In the nearshore sampling zone, a number of stations were sampled before oil from the DWH oil spill was transported into this zone. Many of these stations were re-sampled in September and/or October. Hence, comparison of results from these pre- and post-impact stations was included as an indicator to be used in the evaluation of sub-surface sampling data for the nearshore zone.

2.3 Reference Stations

Historical sediment chemistry data obtained from several sampling programs (Mussel Watch and MMS[1] studies) were used to provide context for observed concentrations associated with response sediment sampling results. Information from reference stations (Fig. 2.1) was used to provide historical data for comparison. These reference datasets will be discussed and referenced in the subsequent sampling zone sections.

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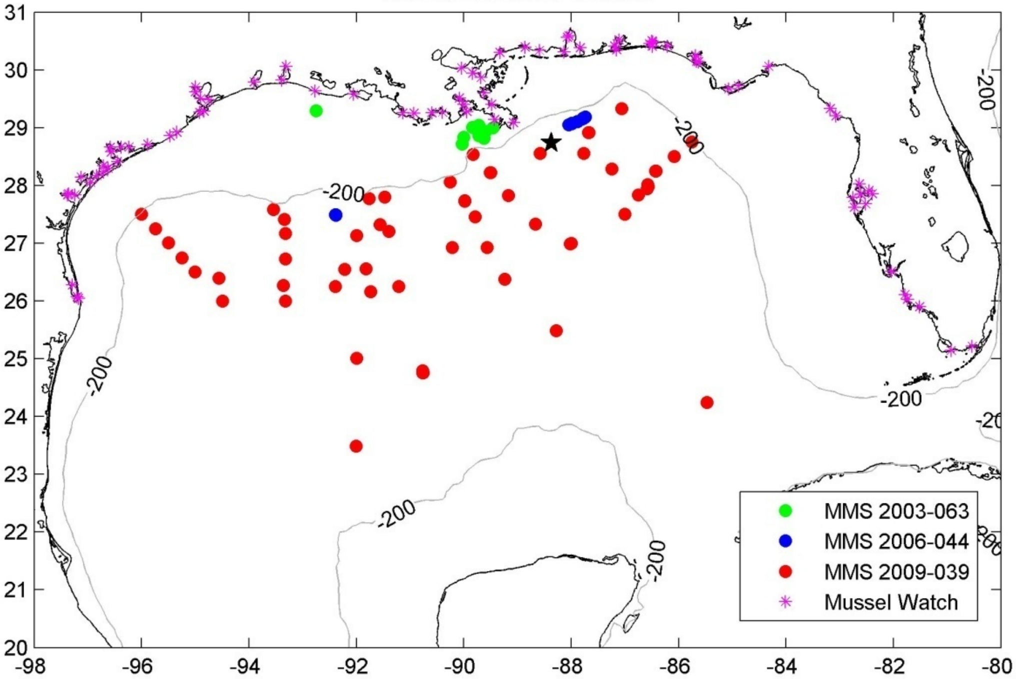
[1] Now the Bureau of Ocean Energy Management, Regulation, and Enforcement (BOEMRE)

These reference concentrations do not represent “background” conditions. Concentrations of PAHs in reference samples do not represent clean or pristine conditions, but represent average concentrations in the zone of interest before the spill. Other sources of PAHs, including seeps may be represented in these comparisons.

Figure 2.1. Location of sediment chemistry reference stations for nearshore, offshore, and deep-water zones.



2.4 Qualitative Observations of Oil

The potential presence of oil in nearshore waters was evaluated using snares and sorbent pads deployed along areas of the coast. These qualitative methods were used continuously in some regions and for periodic screening in other areas. Generally, when oil was observed using these qualitative methods, samples were collected for further chemical analyses. The comprehensive extent of these nearshore qualitative programs makes them an important indicator of potential oil contamination in that sampling zone.

2.5 Significant Toxicity

Toxicity tests were conducted on various benthic and pelagic species. Complete results of those tests were not all available at the time this report was produced. An addendum to this report presenting those results will be produced at a later date.

2.6 Human Health Benchmarks

Human health benchmarks developed by the EPA in coordination with the U.S. Department of Health and Human Services are used to assess potential human health risks from exposure to oil-contaminated water.[1] These benchmarks are based on potential cancer and non-cancer health risks. Where applicable, the benchmarks account for both skin contact and incidental ingestion of water by a child swimmer, assuming 90 hours of exposure (or 1 hour per day for 90 days). The benchmark consists of screening levels for a number of compounds, including volatile organic compounds (VOC), polycyclic aromatic hydrocarbons (PAHs), and metals; see Appendix 1.

2.7 Aquatic Life Benchmarks for PAHs

PAHs are among the most toxic and persistent components of crude oil. PAHs can exhibit both chronic and acute toxicological effects, and several are suspected carcinogens. Accordingly, aquatic life benchmarks for PAHs were selected by the UAC as "indicators" to be monitored.

The EPA established benchmark levels of concern for PAHs in water and sediment to screen for potential adverse impacts to aquatic life.[2, 3] For these benchmarks, a total of 41 oil-related organic compounds are assessed jointly through a mixture approach because they have a cumulative effect on aquatic organisms (Appendix A.3). These compounds include 7 volatile organic compounds, 16 parent PAHs and 18 alkylated homologues of the parent PAHs. The individual compounds are given potency divisors, which are used in calculating the cumulative toxicity of the mixture of compounds in each sample – hereafter referred to as the acute or chronic aquatic life ratio. Aquatic life benchmarks are established based on a suite of laboratory toxicity evaluations using contaminated water and various species, life stages, endpoints, and exposure durations. Sediment benchmarks are based on equilibrium partitioning theory to calculate dissolved concentrations in interstitial pore water and compare them to the same thresholds intended to protect organisms from water column exposures. The amount of total organic carbon (TOC) in the sediment is factored into the calculation because organic matter binds PAHs reducing their availability. To assess the potential hazard to aquatic organisms, the aquatic life ratio is compared to a hazard index of 1. A value >1 indicates that the sample exceeds concentrations calculated to protect aquatic organisms from acute or chronic effects. Appendix A.3 describes the calculation in more detail and includes a complete list of these compounds with their divisors.

Some samples were analyzed only for the parent PAH compounds (this will be noted where applicable in the following sampling sections). When evaluating a sample in which the alkylated PAHs were not measured, it is necessary to compensate for their contribution by using "alkylation multipliers" (Appendix A.3). See Appendix C.3 for a complete discussion of the development of the multipliers and the uncertainty associated with their use with regard to the response sub-surface data.

In addition, some samples collected early in the response were not analyzed for all 16 parent PAHs. These samples are included in this report only for the determination of the

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[1] http://www.epa.gov/bpspill/health-benchmarks.html
[2] http://www.epa.gov/bpspill/water-benchmarks.html
[3] http://www.epa.gov/bpspill/sediment-benchmarks.html

human health benchmark or if they exceeded the aquatic life benchmark. Samples with less than 16 analytes and did not exceed the benchmark, were not included in the total count of non-exceedances for the aquatic life benchmark.

Samples that exceeded EPA aquatic life benchmarks were reviewed to assess the likelihood that contamination resulted from MC252 oil. This was necessary since there are numerous other potential sources for oil related compounds within the Gulf of Mexico. For example, the National Research Council (2003) estimated that 140,000±60,000 tonnes (approximately one million barrels) of petroleum hydrocarbons enter the Gulf of Mexico from natural seeps each year. On an average annual basis the Gulf also receives an additional 10,400 tonnes (approximately 74,000 barrels) of oil spilled from oil production operations, transportation accidents such as tanker leaks, and other sources such as unburned fuel through engines. A three-year study of the source of PAH compounds detected along the Louisiana coast determined that approximately 50% of sources were from petrogenic (crude oil) sources, 36% were from pyrogenic (e.g. combustion or engine exhaust) sources, and 14% were from biogenic or diagenetic sources (Iqbal et al., 2008). To assess the source of the oil related compounds in exceedance samples, the OSAT followed methods described by Bence, et al. (1993) , Boehm (2006) , Overton et al. (2004) , Page et al. (1995) , and Wang (1999). Appendix D details the methodology for this assessment. If enough information was available, a determination was made that the sample was "consistent" or "inconsistent" with MC252 oil. If examination of the sample yielded insufficient data to make the determination, the sample was included as "consistent" in all plots and tabulations of exceedances, i.e. no distinction was made between samples consistent with MC252 and indeterminate samples.

2.8 Dispersant Benchmarks

A total of 1.84 million gallons of dispersants were applied both at the surface (1.06 million gallons, primarily COREXIT 9500A and some 9527) and directly at the wellhead on the seafloor (0.78 million gallons COREXIT 9500A) during the DWH oil spill response (National Commission, 2010b).

These dispersants break down rapidly in seawater; therefore, water samples were analyzed for individual dispersant constituents. Benchmarks (based on dissolved seawater concentrations) for the individual compounds are used to explain the relevance of measured concentrations of individual compounds, i.e., concentrations above benchmark levels are "levels of concern." These benchmarks are based on available biological effects data and are conservatively designed to protect aquatic life (see Appendix A). Four dispersant constituents were analyzed during the DWH oil spill response:

- 2-Butoxyethanol
- Dipropylene Glycol n-Butyl Ether (DPnB)
- Propylene Glycol
- Dioctylsulfosuccinate (DOSS)

These compounds represent major constituents of COREXIT, including those with known toxicology data, and also those with newly established analytical methods. Each of these compounds is also subject to wide commercial use in other products beyond COREXIT. If a benchmark was exceeded, then the potential for other sources of the chemical were also evaluated.

2.9 Hypoxia

Dissolved oxygen was measured in the deepwater zone as part of the sub-surface sampling program beginning in early May. Concern was raised early in the spill that biodegradation of hydrocarbons in the deep dispersed plume would consume dissolved oxygen, potentially decreasing concentrations to levels that could threaten aquatic life (i.e., hypoxia). Hypoxic conditions are generally agreed to occur when dissolved oxygen falls below 2 mg/L (1.4 ml/L).

Section 3: Nearshore Sampling Results

3.1 Description of Sampling and Monitoring Activities in the Nearshore Zone

The nearshore sampling zone is defined as waters inshore of the 3-nmi state waters boundary (Strategic Plan). Qualitative and quantitative data were analyzed to evaluate the distribution and concentration of 1) any remaining oil and oil-related compounds, 2) dispersant-related chemicals, and 3) any associated by-products in this zone.

A number of qualitative observational programs were designed to identify and delineate sub-surface oil in nearshore areas. Water column detection tactics included snare sentinels, sorbent pads, VIPERS (Vessel with Intrinsic Petroleum Ensnaring and Recovery Systems), and snare drag trawls. The snare sentinel and sorbent pad drop programs provided observations at discrete locations at multiple water column depths. Conversely, the VIPERS and snare drag trawl programs were dynamic, and the observations were reported along a cumulative trawl distance. Ponar[1] samples were used to qualitatively assess the presence or absence of oil in sediment samples. When potential oil was encountered using these investigative methods, samples were collected for further laboratory chemical analysis. These observational programs are described in more detail in the Strategic Plan and in Section 3.4.

Water and sediment samples were collected (Maps 7.2a/b; Fig. 3.1) in the nearshore zone at multiple sites for quantitative analysis of oil and oil-related compounds, dispersants, or by-products. The main nearshore sampling efforts were conducted by the EPA, the U.S. Geological Survey (USGS), and the Center for Toxicology and Environmental Health (CTEH; a BP contractor), with additional samples provided by other federal and state agencies. The nearshore sampling plan was designed to determine if the spill had contaminated the sediments and surface waters with oil-related products and/or dispersant-related chemicals. A full description of the derivation of the sampling plan can be found in the Strategic Plan (or see Appendix E.4 for a brief description).

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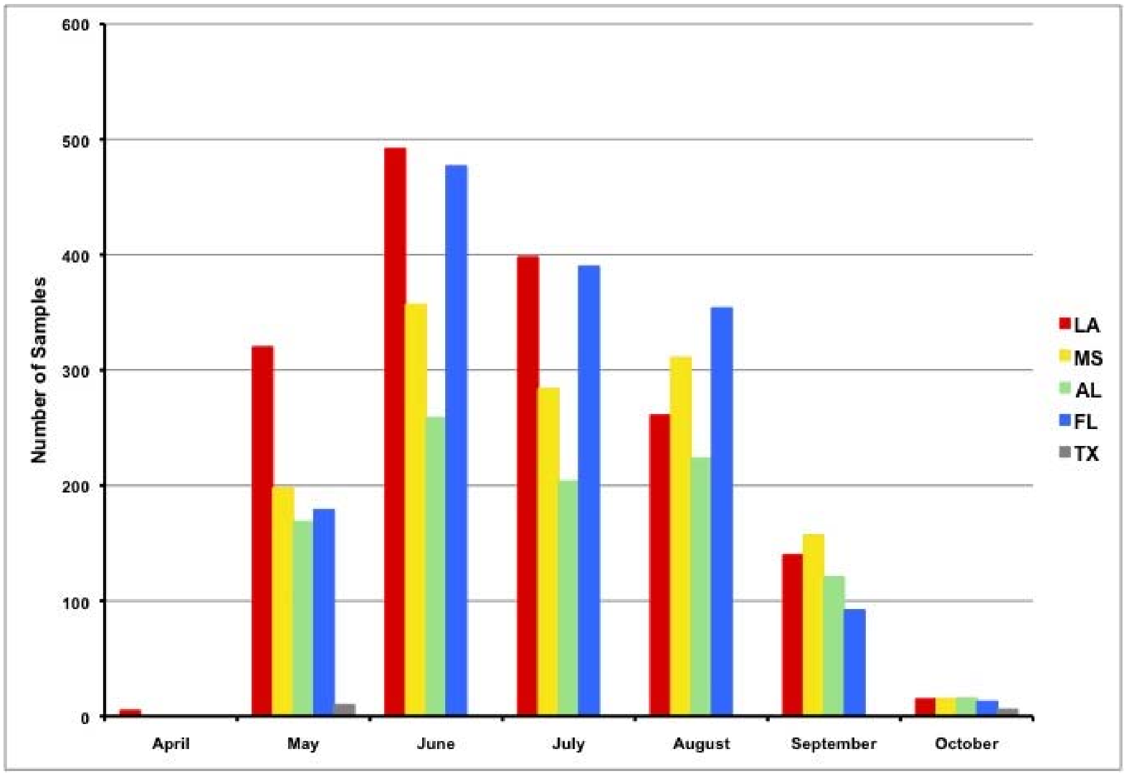
[1] A sediment grab sampler

Figure 3.1. Total number of nearshore water samples collected between 30 April and 18 October, plotted by state and month.



3.2 Fisheries Closures

Fishery closures and re-openings in the nearshore zone are controlled by state agencies. States relied on federal and state testing and FDA recommendations to determine whether fisheries should re-open.

Florida[1] – On 16 June, Florida Fish and Wildlife Commission (FL-FWC) closed all fisheries (except oysters) located between the FL-AL state line and Pensacola Beach as a precautionary response to the DWH oil spill. FL-FWC re-opened the finfish fishery on 31 July, the shrimp fishery on 17 August, and all remaining fisheries on 15 September.

Alabama[2] – Alabama Marine Resource Division (AL-MRD) of the Alabama Department of Conservation and Natural Resources (AL-DCNR) closed both recreational and commercial fisheries when visible oil moved into coastal waters within the nearshore zone. On 1 June, state waters south of Dauphin Island between Mobile Pass and the AL-MS state line out to 3 nmi were closed. On 4 June, waters east to the AL-FL state line were also closed. Mississippi Sound waters were closed between Dauphin Island Bridge and AL-MS state line on 10 June. As of 6 September, all commercial and recreational fisheries in AL state waters were re-opened with the exception of public oyster reefs, which were closed for rehabilitation purposes.

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[1] http://myfwc.com/OilSpill/index.htm

[2] http://www.dcnr.state.al.us/fishing/saltwater/dh/Timeline.cfm

Mississippi[1] – Mississippi Department of Marine Resources (MDMR) closed both recreational and commercial fisheries when visible oil moved into coastal waters within the nearshore zone. On 1 June, MDMR closed all recreational and commercial fisheries in state waters in Mississippi Sound as a pre-cautionary measure. By 1 July, MDMR had closed all state coastal waters to both recreational and commercial fisheries. On 30 July, MDMR re-opened all intra-coastal waters to recreational and commercial finfishing and shrimping. By 21 August, all finfish, shrimp, and blue crab fisheries were re-opened. FDA declared oyster tissue from Mississippi state waters safe to eat on 25 August. MDMR opened oyster beds to harvesting in select waters on 8 and 20 November.

Louisiana[2] – Louisiana Department of Wildlife and Fisheries (LA-DWF) began closing fisheries on the 28 – 29 April as precautionary measures to prevent the harvesting of oil-tainted or oiled finfish, shrimp, or crabs. The delineation of fisheries closures in LA was complex due to the geomorphology of the coastline and the numerous back-barrier and open-water bays. Many of the fisheries were closed between May and August. Re-openings also occurred during this period; detailed time-series maps of opening and closures are provided at the LA-DWF website. As of 8 November, 98.5% of state waters have been reopened for commercial fishing.

3.3 Reference Stations and Pre-Impact Data

The OSAT reviewed sample data from the Mussel Watch program to establish reference conditions for oil-related compounds that may have been present prior to the MC252 spill. Since 1986, NOAA's Mussel Watch program has consistently studied and monitored 300 sites around the country for over 100 organic and inorganic pollutants in sediments, oysters, and mussels. The Mussel Watch dataset that the OSAT used for the Gulf coast included data from 1989 - 2007 at 98 unique locations (Fig. 2.1). Only 1 of the 163 total Mussel Watch sediment samples considered exceeded the chronic aquatic life benchmark. This sample was collected offshore of Pensacola and had a classic pyrogenic signature (Appendix D). The chronic aquatic life ratios for Mussel Watch ranged from $1.4\text{x}10^{-5}$ to 1.26, with an average ratio of 0.020.

Pre-impact sediment samples were collected in the nearshore zone at multiple locations before landfall of oil associated with the DWH oil spill. Pre-impact samples refer to samples collected before 15 May for LA and 1 June for AL/MS/FL. These dates approximate the point in time when visible oil reached the shoreline in these different areas. A total of 239 pre-impact sediment samples were collected in April and May, of which 96 samples had detected oil-related organic compounds. The chronic aquatic life ratios for pre-impact data ranged from 0 to 8.5, with an average of 0.13 across all samples. For comparison to post-impact data, an average chronic aquatic life ratio equal to 0.084 is used, which was computed from all Mussel Watch and pre-impact data for the Gulf coast.

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[1] http://www.dmr.state.ms.us/

[2] http://www.wlf.louisiana.gov/oilspill/actions

3.4 Qualitative Observations of Oil

Various qualitative methods were used to determine if oil was present in the sub-surface environment. These activities were conducted by the two primary Incident Command Posts (ICPs) in Mobile, AL and Houma, LA; the two ICPs had defined areas of responsibility (AORs). With respect to the nearshore sampling zone, the Mobile ICP conducted qualitative sampling programs in MS, AL and FL, whereas the Houma ICP conducted programs in LA.

Several qualitative programs were designed to detect the presence of oil in the water column. In the Mobile AOR, VIPERS trawled 266 nmi along the 3 nmi state waters boundary from Cat Island, Mississippi, to Bay County, Florida between 22 August and 9 September. Only one small tar ball was recovered near Panama City, FL, on the 24 August and source characterization analysis indicated it was inconsistent with MC252 (Appendix D).

Sorbent probes were also utilized at 5,880 sites in MS, AL and FL to identify potential oil in the water column. Potential oil presence was noted at six sites in the MS Sound. Follow-up (analytical) water samples collected in these areas did not detect oil. Oil was observed on 4 poms from a total of 108 snare drag trawls along 164 nmi in Breton Sound on 14–15 August. The 4 poms were collected from the same general area, and analytical results indicated weathered MC252 oil equivalent to a total of 10 mg/L of oil. No oil was detected during snare drag trawls conducted in Barataria Bay on 18–30 August.

Between 25 August and 12 September, 148 snare sentinels were deployed along the shorelines of Mississippi, Alabama, and Florida; 16 snares were reported as “very lightly oiled”. The snares along with 36 water samples and 5 sediment samples collected near these snares were submitted for analysis. Forensic fingerprinting results from all 16 snare samples were interpreted as “unlikely Macondo (MC252 oil) derived” (Snare Sentinel Summary Report, 25 September). Analyses of Oil Range Organics (OROs), Volatile Organic Compounds (VOCs), Semi-Volatile Organic Compounds (SVOCs), Nickel, and dispersant indicators in water samples were below minimum detection limits. Diesel Range Organics (DROs) were detected in 2 of 36 water samples at concentrations ranging from 49.7 to 56.0 µg/L. Vanadium was present in 31 of 36 water samples at a maximum concentration of 76 µg/L, well below the 5400 µg/L USEPA Human Health Benchmark for a Child Swimmer. Fingerprint analyses determined that 1 of the 5 sediment samples was identified as MC252 oil. The remaining four sediment samples were determined to be “unlikely Macondo (MC252 oil) derived.” The Mobile ICP Operations Unit concluded that no recoverable amounts of oil were identified using this procedure.

Within the Houma AOR, 449 locations were occupied using a similar snare sentinel program between 28 July and 2 October (UAC Snare Summary Report, 30 November). Sites spanned the nearshore region from Caillou Bay east to Chandeleur Sound. Oiled surface snares were recovered from four regions: Timbalier Bay, Barataria Bay, Chandeleur Sound and off the Mississippi River Delta. Oiled bottom snares were recovered from Barataria Bay and Timbalier Bay. Out of 6,911 observations, 40 snare sentinel at 32 unique locations were reported as oiled (26 top, 12 middle and 21 bottom). The most recent surface detection was 31 July in Barataria Bay, and the most recent sub-surface detection was 20 September in Barataria Bay. All observations of sub-surface oiling were located off previously oiled shorelines. Based on these data, the OSAT inferred that future detection of sub-surface MC252 oil by Snare Sentinels would most likely be due to remobilization of oil already present in the nearshore environment (i.e., in known regions of heavily oiled shoreline), and on 18 October recommended phasing out the Louisiana Snare Sentinel program (Appendix F.10).

To assess oil presence in bottom sediments, samples were collected at 2066 sites using a stainless steel Ponar grab sampler in the Mobile AOR. The bottom material was visually inspected for the presence of oil. If oil presence was suspected, then a representative sample was sent for laboratory analysis. Based on visual inspection, 32 sediment samples were sent for laboratory analysis. Three samples collected on the back side of barrier islands near Pensacola, FL contained detectible oil concentrations.

The three sites confirmed to have oil present in sediments by Ponar surveys, are consistent with one of the regions identified by SCAT teams as potentially having submerged tar mats. Early on during the response, the possible formation of tar mats (i.e. submerged sedimented oil) in the nearshore region was recognized (see NOAA-ORR, 2010 for a description of how they form). The OSAT noted that a data gap may exist since the assessment programs were generally unable to monitor in waters shallower than ~10 feet. Submerged tar mats have been identified in some areas from the lower intertidal zone out to the super low tide zone by SCAT teams. Tar mat locations have been directly observed by SCAT teams using snorkeling equipment. Location of tar mats have also been inferred from observations of shoreline tar ball re-oiling. Currently, SCAT teams are monitoring these known sites and operational clean-ups will occur if shoreline re-oiling is observed.

3.5 Comparison to Human Health Benchmarks

A total of 6090 water samples were considered for comparison to the Human Health Benchmarks. (Table 3.1, Map 7.6). None of samples exceeded the EPA benchmark for human health (child swimmer scenario).

3.6 Comparison to Aquatic Life Benchmarks

Chronic and acute aquatic life ratios were calculated for all samples (water and sediment) from the nearshore zone in which PAH compounds were analyzed. Of total 6701 samples, the full suite of analytes was quantified for 511 samples (7.6%). In most of the samples only the parent PAHs were quantified. The OSAT recognized this issue soon after they began reviewing the dataset and made a recommendation that all future samples be analyzed for the complete set of analytes (20 September, Appendix F). Therefore, many of the more recent samples were analyzed for the full suite of PAHs. These samples are the most essential for determining post-impact environmental conditions. However, where only the 16 parent PAHs were reported, mulitpliers were used to account for the missing alkylated PAHs (Appendices A.3, C.3).

A total of 41 nearshore water benchmark exceedances were observed throughout the incident (Maps 7.4a/b. Fewer benchmark exceedances were observed in EPA Region 6 (LA and TX; Fig. 3.2) than in EPA Region 4 (AL, MS, and FL; Fig. 3.3). Of these exceedances, 13 samples were of indeterminate origin, 19 were considered not consistent with MC 252 oil, and 9 were deemed consistent with MC252. No water benchmark exceedances measured after 3 August were consistent with MC252 oil (Table 3.2).

Figure 3.2. Temporal distribution of chronic aquatic life ratios for PAHs in Region 6 (LA and TX) nearshore water samples. Red circles indicate samples that exceeded the chronic aquatic life benchmark and yellow circles indicate exceedance samples that were not consistent with MC252 oil. The blue dotted line corresponds to the aquatic life benchmark of 1. The date tick mark in all figures corresponds to the first of the month.

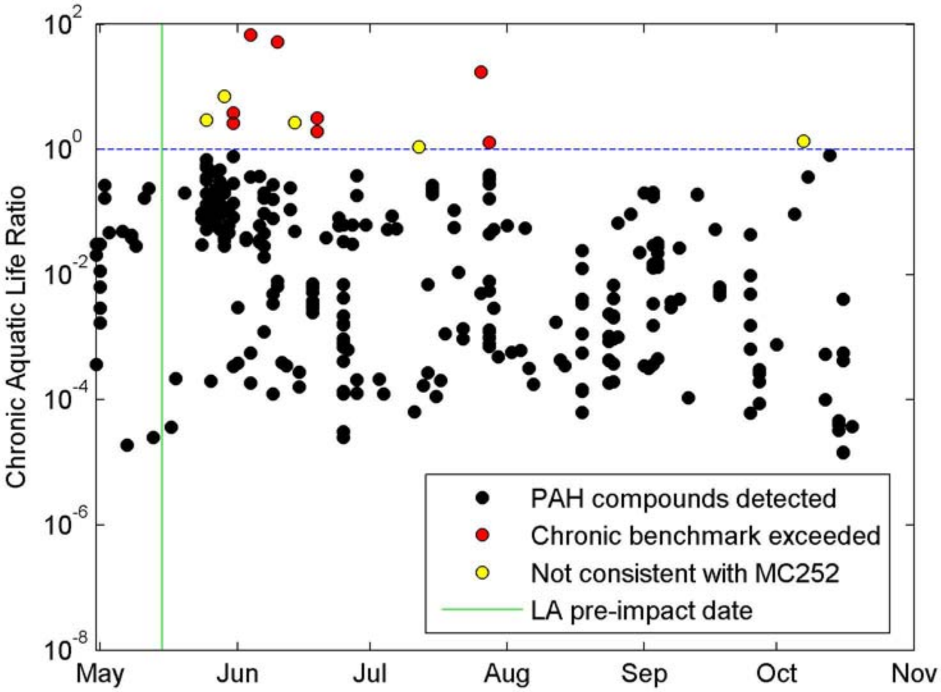
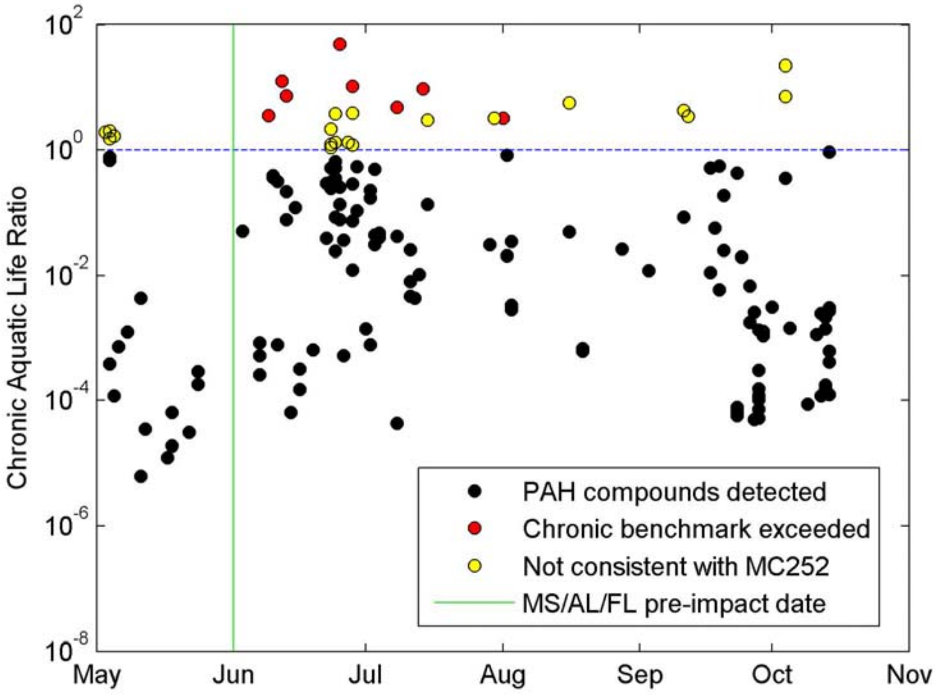


Figure 3.3. Temporal distribution of chronic aquatic life ratios for PAHs in Region 4 (AL, MS, and FL) nearshore water samples. Symbols are the same as in Fig. 3.2.



A total of 24 nearshore sediment benchmark exceedances were observed throughout the incident (Maps 7.5a/b). As with water, fewer sediment benchmark exceedances were observed in EPA Region 6 (TX and LA; Fig. 3.4) than in EPA Region 4 (AL, MS, and FL; Fig. 3.5). In EPA Region 4, some of the samples indicating pre-impact sediment benchmark exceedances did not have enough information to determine oil source since only the 16 parent PAHs were measured. In the absence of additional information, these were included as MC252 exceedances, although they occurred before MC252 oil was observed to have been present in the nearshore zone in this region (red dots prior to 1 June in Fig. 3.5). Of the total exceedances, 9 samples were of indeterminate origin, 11 were considered not consistent with MC252, and 4 were consistent with MC252. All exceedances after 3 August were inconsistent with MC252 oil (Table 3.2).

Chronic aquatic life ratios for sediments were also compared to the average ratio for pre-impact and reference samples. This average ratio, which will be referred to here as the "reference ratio", equaled 0.084 (Section 3.3). After 3 August, all sediment samples collected in both Regions 4 and 6 (Figs. 3.4 and 3.5) had ratios that were, on average, below the reference ratio. By the end of sampling in October, all sediment samples were below the reference ratio, indicating that pre-impact average concentrations had been reached.

Figure 3.4. Temporal distribution of chronic aquatic life ratios for PAHs in Region 6 (LA and TX) nearshore sediment samples. Symbols are the same as in Fig. 3.2. The green line corresponds to the average chronic aquatic life ratio in reference and pre-impact samples.

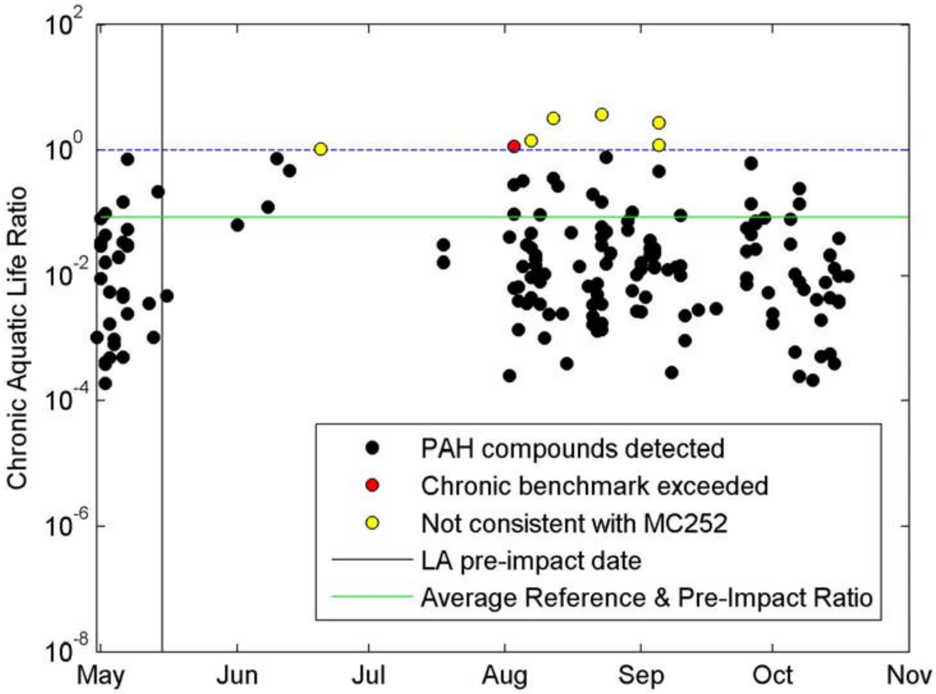


Figure 3.5. Temporal distribution of chronic aquatic life ratios for PAHs in Region 4 (AL, MS, and FL) nearshore sediment samples. Symbols are the same as in Fig. 3.2. The green line corresponds to the average chronic aquatic life ratio in reference and pre-impact samples.

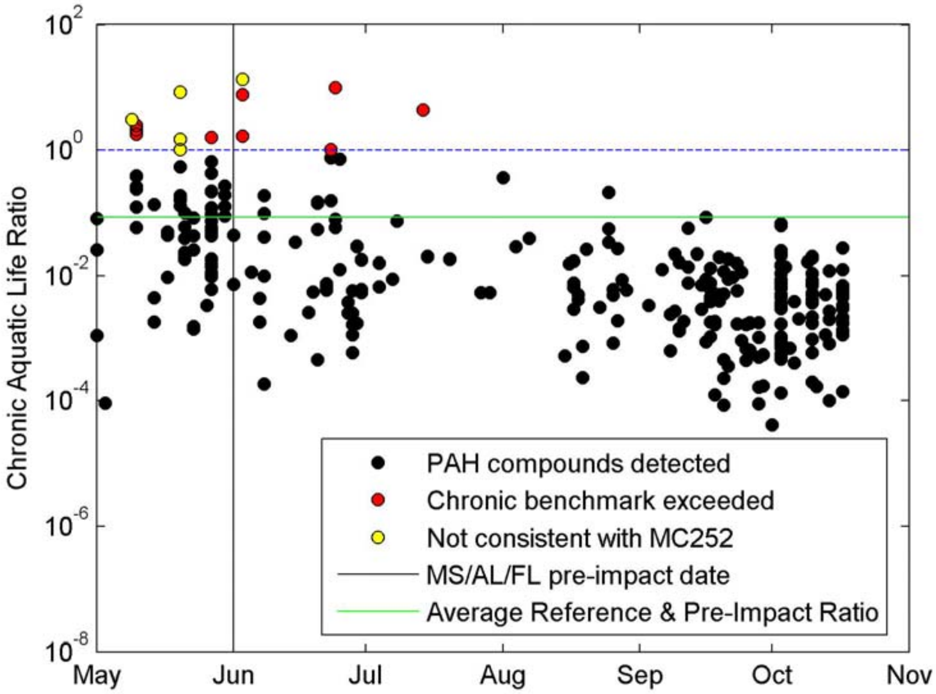


Table 3.1. Summary of water and sediment analytical chemistry results in the nearshore zone. Datasets were compared to human health benchmarks, aquatic life benchmarks, and dispersant screening levels. For each benchmark (or screening level), total numbers of samples that were non-detect, below benchmark, or exceeded the benchmark were computed. The total number of samples is not the same for the human health, aquatic life, or dispersant categories because not all samples were analyzed for all analytes.

Sample Type	Indicator Level	Human Health	Aquatic Life	Dispersant
Water Column	Non-detect	3405	5337	4790
	Below Benchmark	2685	395	60
	Exceed Benchmark	**0(0)***	**41(22)***	**0**
Sediment	Non-detect	n/a	671	406
	Below Benchmark	n/a	441	6
	Exceed Benchmark	**n/a**	**24(13)***	**n/a**
Total Samples		**6090**	**6909**	**5262**
Total Exceedances		**0**	**65(35)**	**0**
Percent of Exceedances		**0%**	**0.94%**	**0%**
Total Exceedances After 3 August		**0**	**11(0)**	**0**

*The number in parentheses refers to exceedances consistent with MC252 oil or indeterminate.

Source characterization of exceedances

Any water or sediment sample that exceeded the aquatic life benchmark was examined in detail to assess the likelihood that the exceedance was due to MC252 oil (Table 3.2; see Appendix D for source characterization process). The majority of samples that were not consistent with MC252 were from pyrogenic sources (combustion related).

Table 3.2. List of aquatic life benchmark exceedances for water and sediments in the nearshore zone after 3 August. Details are listed for each exceedance including the source of the oil, identified as follows: (1) consistent with MC252 oil, (2) not consistent with MC252 oil, and (3) indeterminate. Highlighted rows indicate sediment samples; non-highlighted rows indicate water samples.

Sample Date	Type of Exceedance	Sample Location		Sample ID	Source
		Lat	Long		
8/7/10	Chronic	29.41648	-90.04369	T007-1331-100807-SD-1	2
8/12/10	Chronic	29.65621	-92.82204	T008-0029-100812-SD-1	2
8/16/10	Acute	29.68642	-84.78892	BCH11-SW-201008	2
8/23/10	Chronic	29.31747	-94.79753	SL-20100823-SR3-002	2
9/5/10	Chronic	29.72568	-88.98950	T001-R678-100905-SD-1	2
9/5/10	Chronic	29.87817	-88.88842	T001-R680-100905-SD-1	2
9/11/10	Acute	30.37534	-88.60680	WPR1-SW-09112010	2
9/12/10	Chronic	30.60264	-87.94630	UpMB-SW	2
10/4/10	Acute	30.31314	-86.12028	SBFL1004SW0103	2
10/4/10	Acute	30.32568	-87.17510	PEL1004SW0103	2
10/7/10	Chronic	28.99191	-89.14442	SW-20101007-USGSLA1-LA-35-003_LLI	2

*Source = "consistent with MC252 oil (1), "not consistent with MC252 oil" (2), "indeterminate" (3)

3.8 Comparison to Dispersant Benchmarks

While dispersants were not used in the nearshore sampling zone as part of the response, there were concerns that dispersant-related chemicals could be transported into the nearshore zone. Sediment and water samples collected in the nearshore zone were analyzed for a number of dispersant-related chemicals, including, but not limited to DPnB, Propylene glycol, and DOSS (Appendix A.1). Between 13 May and 20 October, 4850 water and 412 sediment samples were collected in the nearshore zone (Table 3.1). None of the concentrations of dispersant-related chemicals found in water samples collected during the response exceeded the benchmarks. Only 66 samples (60 water and 6 sediment) had detectable levels of dispersant-related chemicals. DPnB was the most common detectable dispersant-compound and was found in 57 of the 60 water samples; however, concentrations never exceeded 3 μg/L (cf. EPA screening level 1 mg/L). Presence of dispersant-related chemicals in water occurred all along the Gulf coast; however, a majority of the nearshore detects were encountered around LA (Map 7.7). The most recent detect for the water samples was 18 October. Propylene glycol was the only dispersant-related chemical detected in the sediments (Map 7.8). Unfortunately, no benchmark for dispersant indicator compounds in sediment exists, thus the significance of these concentrations is unknown. The most recent detect for sediments occurred in a sample collected on 28 September.

Section 4: Offshore Sampling Results

4.1 Description of Sampling and Monitoring Activities in the Offshore Zone

The offshore sampling zone is defined as the geographic region between the state water's boundary and the 200 m bathymetric contour, which delineates the continental shelf break (Map 7.1). This region was identified as a sampling gap (particularly for sediments) in the Strategic Plan: prior sub-surface sampling had primarily been conducted in the deep-water and nearshore zones.

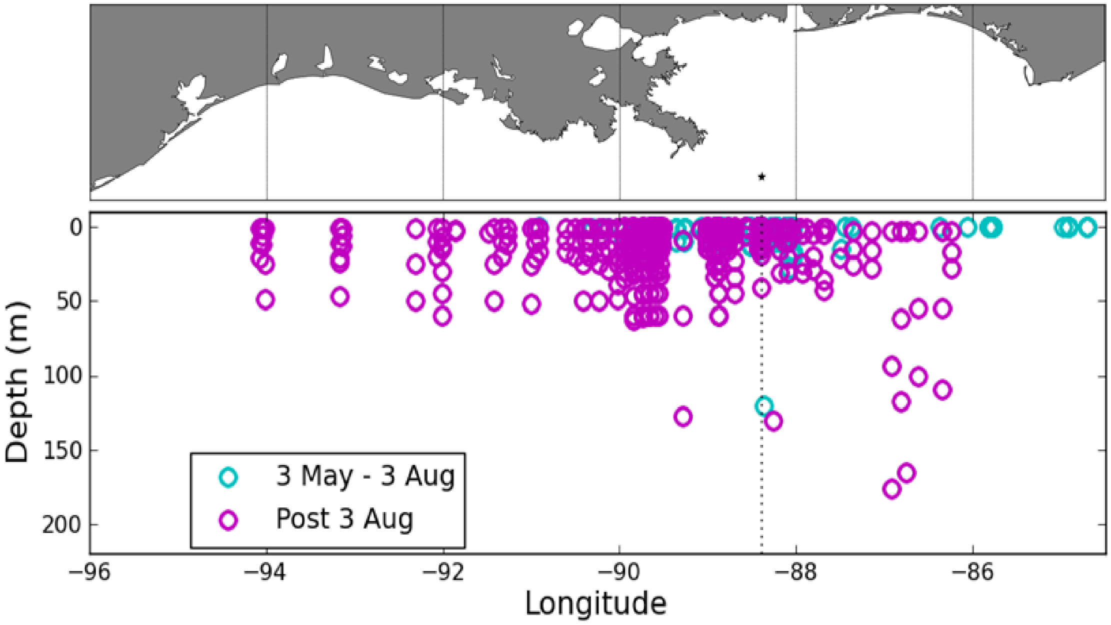
This zone was targeted for sampling by two main programs (see Map 7.3 for stations with analytical data available for this report). The first sampling program, the Fate of Oil Research Team (FORT) conducted water sampling (CTD rosette) and sediment sampling (grab sampler) on 15 cross-shelf transects from east of the Mississippi River Delta (offshore of Breton Sound) west to Port Arthur, TX (alongshore spacing of the transects increased west of Houma, LA. FORT resulted in 240 water samples and nearly 60 sediment samples from late August through mid-October.

The second sampling program was the offshore component of the response's sub-surface monitoring program (Operational Annex). This sampling program collected 93 sediment samples. Water sampling at discrete depths was co-located with a subset of the sediment sites (40 water samples were taken). The sampling strategy identified sampling locations with the highest potential for oil to be found in sediments based on the intersection with the freshwater convergence zone of the Mississippi River, the locations of aerial dispersant applications, and the movement of oil based on currents. Once targeted sample locations were determined, additional statistically based samples were added to ensure statistical rigor (see the Strategic Plan and Operational Annex). Most of the sediment samples were taken with a multi corer. Shallow areas and areas with sand or shell bottom were sampled with a sediment grab or a box corer.

In addition to the response sampling, NOAA also provided samples for analysis that were collected during a cruise for "The Regional Assessment of Ecosystem Condition and Stressor Impacts" along the Northeastern Gulf of Mexico Shelf aboard the NOAA Ship R/V *Nancy Foster* (August 12–22). This cruise sampled for a variety of parameters, but only the data applicable to the response were analyzed. Included in this dataset were 50 sediment samples taken during the cruise.

At the time of this report approximately 700 water and 250 sediment samples in the offshore sampling zone had been analyzed and published to Scribe (see Table 4.1 for the sample count breakdown by indicator; Map 7.3 shows the geographic coverage). The distribution of the water sampling with depth is detailed below (Fig 4.1). Most of the sampling was in the upper 50 m of the water column and occurred after 3 August, i.e. as a component of the comprehensive sub-surface sampling efforts stemming from the NIC directive.

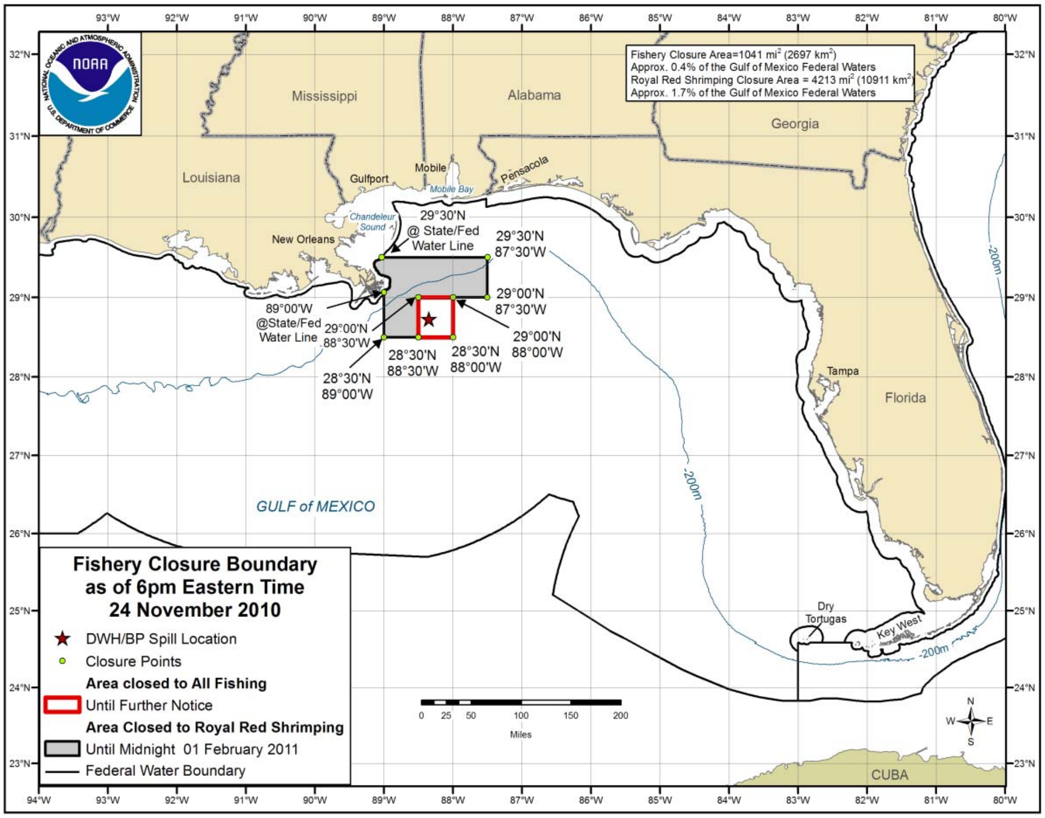
Figure 4.1 Offshore water sample locations as a function of depth. The black dot in the top panel denotes the wellhead location.



4.2 Fisheries Closures

At its peak, 37% of Gulf waters (88,522 mi^2) were closed to fishing on 2 June due to the DWH oil spill. Prior to re-opening, fish samples in all areas went through sensory testing and analysis for PAH chemical contaminants. After an extensive consultation with the FDA, NOAA re-opened approximately 26,388 mi^2 on 22 July at the southern extent of the federal closed area (Fig. 4.2). Additional shelf areas were re-opened in August and early September, extending from western Louisiana through the Florida panhandle. On 21 September, NOAA re-opened 7,970 mi^2 of Gulf waters to recreational and commercial fishing along the southern boundary of the federal closed area. Most remaining areas were re-opened during October and November as per the order shown in Fig. 5.2. However, on 24 November one of the re-opened areas was closed again when tarballs were found in nets with Royal Red Shrimp. Currently, 4,213 mi^2 remain closed to Royal Red shrimping in an area covering portions of the OSAT's offshore and deep-water zones. Several vessels have been investigating this region further, performing trawls of the seafloor. Findings thus far have been of a few tarballs from several of the grids, generally less than 2 inches in diameter. Tarballs were described as not-sticky (in that they did not adhere to the nets). The origin of these tarballs has not yet been determined.

Figure 4.2. A square region around the wellhead remains closed to all fishing (red box), and another region north and west of the wellhead was closed on 24 November to Royal Red shrimping (gray area).



4.3 Reference Stations

An MMS study by Turner et al. (2003) focused on the Louisiana Bight region west of the Mississippi River Delta of the Mississippi River. Concentrations of PAHs in sediment cores ranged from 5.5 ng/g to 1200 ng/g (average 154 ng/g). The acute and chronic aquatic life ratios were calculated for the samples taken from the top 1 to 5 cm of each core (a TOC value of 1% was used in the calculation). No samples exceeded the acute or chronic aquatic life benchmarks. The average value of the chronic aquatic life ratios from these cores was used as the reference level in the figures below.

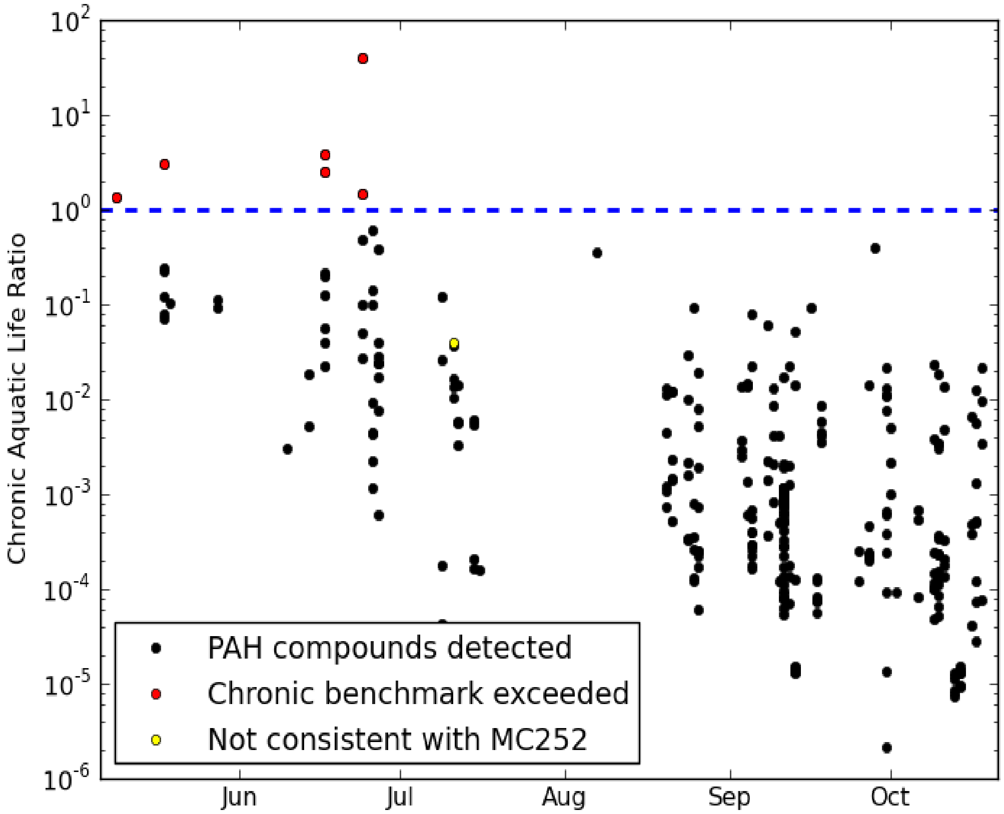
4.4 Qualitative Observations of Oil

Sediment cores and grabs collected in the offshore sampling zone were initially inspected for visual or olfactory indications of oil. These qualitative sensory inspections gave real-time preliminary indications of where oil contamination of sediments might have occurred. These results were used to inform the sampling plan and to make any adaptations to address areas of potential concern. Several cores from stations in the vicinity of the Mississippi River freshwater convergence zone showed qualitative indications of oil. The OSAT recommended additional sediment sampling in this region to ensure adequate coverage in the event that analytical results confirmed presence of MC252 oil in these samples (OSAT Recommendation, 19 October, Appendix F.11).

4.5 Comparison to Aquatic Life Benchmarks

Chronic and acute aquatic life ratios were calculated for all samples in which PAH compounds were analyzed (Maps 7.4a and 7.4b; Table 4.1). In the offshore sampling zone, the majority of the samples (~70% of water samples and 90% of sediment samples) were analyzed for the full suite of analytes (parent PAHs and alkylated PAHs). However, the analyses for the volatile organic compounds (e.g. benzene, toluene, ethylbenzene and xylene) were given a different sample name and it was not possible to match up the samples within Scribe and hence they were not included in the aquatic life ratio calculation (for more information on this problem and its implications see Appendices C.1 and C.5, respectively). Any water or sediment sample that exceeded the aquatic life benchmark was examined in detail to assess the likelihood that the exceedance was due to MC252 oil (see Appendix D for source characterization process).

Figure 4.3 Chronic aquatic life ratio in water samples as a function of time. Red dots above the dashed line exceed the chronic aquatic life benchmark. The six exceedances are near surface (~1 m) samples.



Six water samples in the offshore sampling zone exceeded the EPA chronic aquatic life benchmark. One of these six also exceeded the acute aquatic life benchmark. All six were near-surface samples (~1 m) collected in May and June (Fig. 4.3). Five of these samples were collected in association with the Dispersant Environmental Effects Project (DEEP;

Appendix C.11) which targeted regions of observed surface oil before and after dispersant application. No samples exceeded the benchmark after 3 August.

In sediment samples, none of the samples exceeded the EPA chronic aquatic life benchmark in the offshore zone (Maps 5a and 5b; Fig. 4.4; Table 4.1). There were very few sediment samples in this zone prior to the sub-surface sampling efforts that occurred in late-August through October, however, comparison with the average chronic aquatic life ratio calculated from the reference dataset (Section 4.3), indicates most of the samples have ratios that are below this level.

Figure 4.4 Chronic aquatic life ratio in sediment samples as a function of time. There were no exceedances of the chronic aquatic life benchmark. The green line corresponds to the average chronic ratio at offshore reference stations.

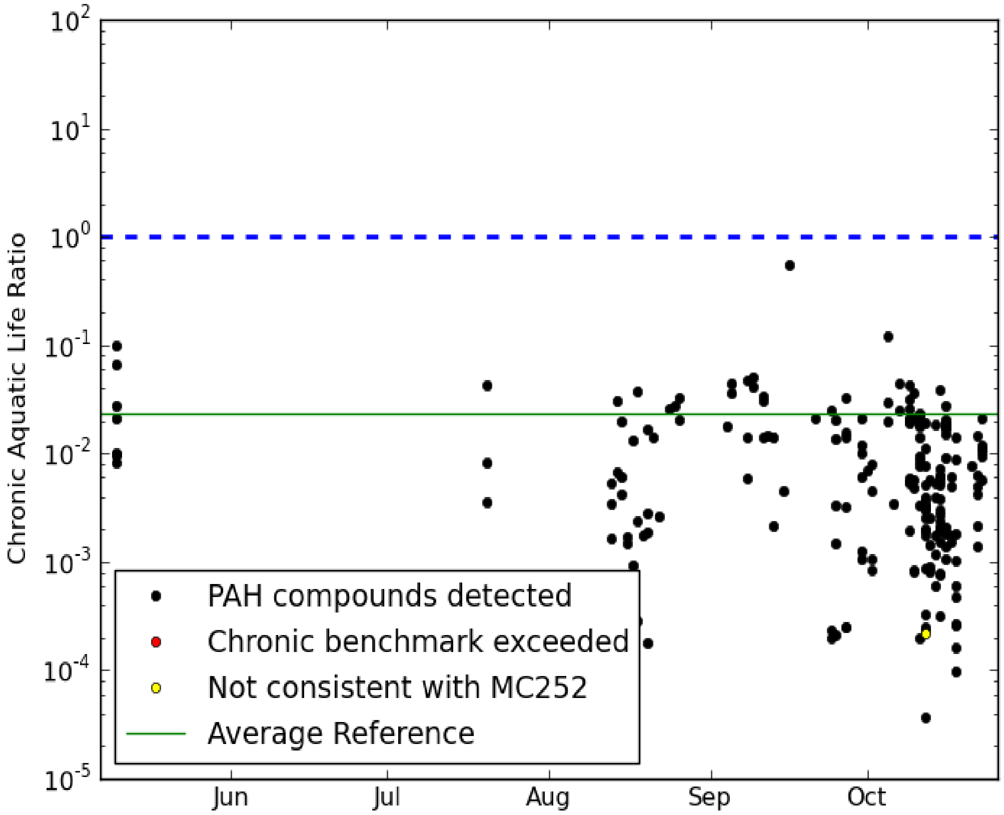


Table 4.1. Summary of water and sediment analytical chemistry results in the offshore zone. Datasets were compared to benchmarks for human health, aquatic life, and dispersant chemicals. For each benchmark, total numbers of samples that were non-detect, below benchmark, or that exceeded the benchmark were computed. The total number of samples is not the same for the human health, aquatic life, or dispersant analyses because not all samples were analyzed for all analytes.

Sample Type	Indicator Level	Human Health	Aquatic Life	Dispersant
Water Column	Non-detect	508	192	241
	Below Benchmark	242	283	199
	Exceed Benchmark	**0(0)***	**6(6)***	**0**
Sediment	Non-detect	n/a	61	242
	Below Benchmark	n/a	207	1
	Exceed Benchmark	**n/a**	**0**	**n/a**
Total Samples		**750**	**749**	**682**
Total Exceedances		**0**	**6(6)**	**0**
Percent of Exceedances		**0%**	**0.80%**	**0%**
Total Exceedances After 3 August		**0**	**0**	**0**

*The # in parantheses refers to exceedances consistent with MC252 oil.

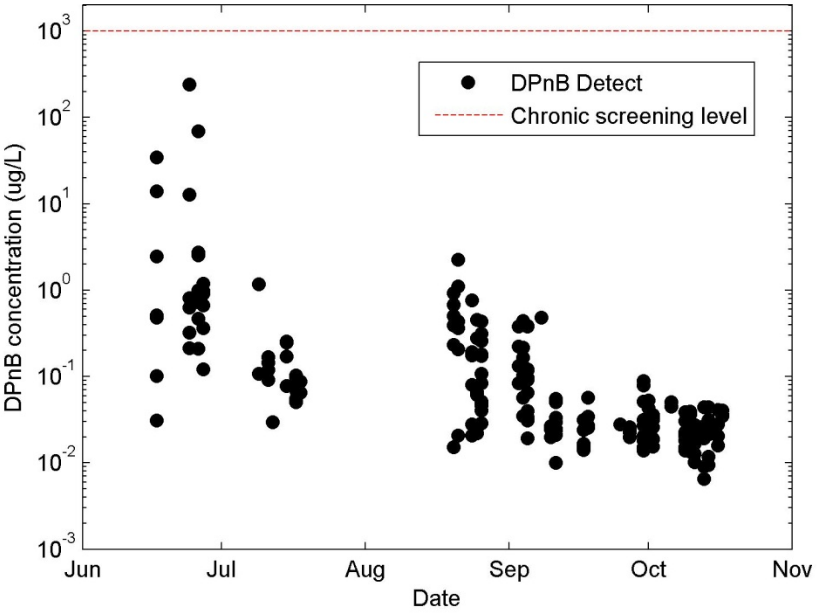
Table 4.2. List of aquatic life benchmark exceedances for water and sediments in the the nearshore zone after 3 August. Details are listed for each exceedance including the source of the oil, identified as follows: (1) consistent with MC252 oil, (2) not consistent with MC252 oil, and (3) indeterminate.

Sample Date	Type of Exceedance	Sample Location	Sample ID	Source
NONE	NONE			

4.6 Comparison to Dispersant Benchmarks

There were no exceedances of the dispersant-related chemicals benchmarks in the offshore sampling zone. Approximately half the samples in the offshore zone had detections of dispersant-related chemicals in water samples (199/440). Figure 4.5 shows the concentration of DPnB in water samples collected in the offshore zone over the course of the response. In sediment samples, there was only one detect of a dispersant-related chemical out of 243 samples.

Figure 4.5 DPnB concentration over time. Note that no samples exceeded the benchmark.



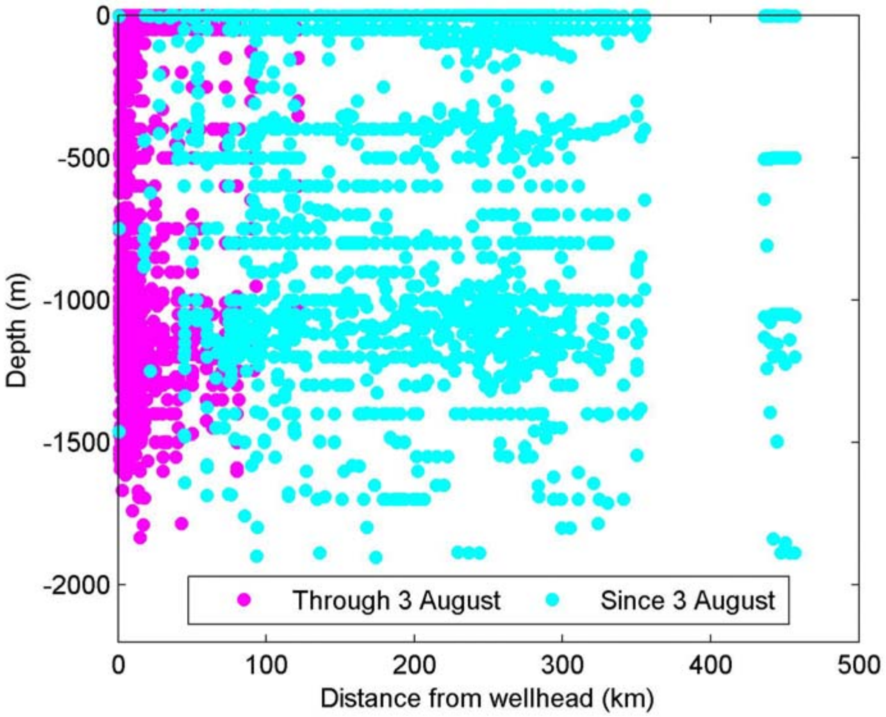
Section 5: Deep-Water Sampling Results

5.1 Description of Sampling and Monitoring Activities in the Deep-water Zone

The deep-water zone is defined as the region seaward of the 200-m bathymetric contour (approximately the continental shelf break; Map 7.1). Beginning in May 2010, extensive water sampling in this zone was conducted by private, federal, and academic scientists.

Water samples were collected by a number of vessels (NOAA, BP contract, and academic) operating both in the vicinity of the wellhead and in the far field (Map 7.3). Conductivity/temperature/depth (CTD) casts—vertical profiles measuring physical and chemical water properties—were conducted by most of the sampling vessels operating in the deep-water zone. The CTD sensor array typically included a dissolved oxygen sensor and a fluorometer for qualitative screening of hydrocarbon signatures. Water samples collected at discrete depths were analyzed for a number of parameters, including oil chemistry, dispersant indicators, and toxicity to rotifers and luminescent bacteria (data to be presented as a addendum to this report). Analytical data were uploaded to the Scribe database for comparison with water-quality benchmarks for the deep-water zone (Section 2). The distribution of analytical data available in Scribe is shown with respect to depth and distance from the wellhead in Figure 5.1.

Figure 5.1. Distribution of analytical data for deep-water sampling zone. Data spans the period from 9 May through 16 October. Different colors denote sampling through and since 3 August.



Early in the response, observations from vertical profiles within approximately 30 km of the wellhead identified a signature of dispersed oil droplets in a depth range of 1100–1300 m. Much of the subsequent work in the deep-water zone focused on delineation and characterization of this sub-surface plume. From mid-July onward, a mission guidance program provided coordination, allowing for the multiple vessels to more efficiently and effectively sample the deep water and to create a 4D image of dispersed oil in the sub-surface. To coordinate and direct the sampling, mission guidance was kept informed by daily reports from Chief Scientists in the field, real-time analysis of data, knowledge of ocean currents, and predicted fate and transport of dispersed/dissolved oil from trajectory models. Further review of data for the sub-surface plume showed that it was generally confined to a specific density layer defined by potential density 1027.70–1027.71 kg/m^3.

Sub-surface monitoring, trajectory models, and ocean current data indicated that the overall movement of the sub-surface plume would be primarily along bathymetric contours to the southwest. A significant water-sampling effort effectively characterized the plume as it moved to the southwest; this sampling spanned the along-shelf region from the wellhead out to 500 km to the southwest and 200 km to the northeast. However, sampling was not temporally linked to strong current reversals, particularly to the NE when movement into that region would occur. In late September, after analysis of recent results and comparison with water-quality indicators, the OSAT recommended that further far-field water sampling of the dispersed oil plume was no longer necessary as part of the response (OSAT recommendation 1, 20 September 20, App. F).

As much of the sampling in August and September had focused on delineating this deep plume as it moved to the southwest, observations since July in the vicinity of the wellhead were limited. As part of the Strategic Plan, the OSAT recommended a limited number of stations in the near-field be resampled (20 September, App. F.1). Many of these stations had been sampled very early in the spill and indicated oil presence. These stations were revisited in late September.

At the time of this report, approximately 4000 water and sediment samples from the deep-water zone had been analyzed and published to the Scribe database (Map 7.3; Fig. 5.1; Table 5.1). Due to the evolution of sampling described above, the bulk of the samples from May through early August are in the near-field vicinity of the wellhead, whereas the bulk of the samples from August and September are primarily to the southwest. In September, water sampling in the deep-water zone was limited to the near-field stations mentioned above.

The need for sediment sampling in the deep-water zone was identified as a sampling gap in the Strategic Plan. This sampling was undertaken beginning in late September. Samples were collected using a Mega Corer in the near field around the wellhead, and in the far field toward the northeast and southwest (in the along-shelf direction). Sediment cores (Map 7.3) were analyzed for oil chemistry and microtox toxicity.

5.2 Fisheries Closures

Many of the fishery closure areas span both the offshore and deep-water zones, and were discussed earlier in Section 4.2. A deep-water fisheries area that has yet to be re-opened is a square region around the wellhead that is approximately 30x30 nmi in size (1041 mi^2) (Fig. 4.2). One factor determining the re-opening of this region is the decontamination of the M/V *Discoverer Enterprise* drillship in deep water, which is currently in process.

5.3 Reference Stations

Reference stations for sediments in the deep-water zone were obtained from two historical MMS studies. The 2009 MMS study (Rowe and Kennicutt, 2009) was part of the Deep Gulf of Mexico Benthos (DGoMB) project and resulted in the collection of sediment samples at 67 different locations, during 2000–2002 (Fig. 2.1). The sediment PAH values were in the range of 0 to 1033 ng/g (mean of 139.5 ng/g). The acute and chronic ratios for comparison to EPA's aquatic life benchmarks were calculated for these samples, and all ratios were well below the benchmark of 1 (ranging from 0.0011 to 0.1881 for the chronic ratio).

The 2006 MMS study (Continental Shelf Assoc., 2006) measured sediment PAHs at 45 locations in four distinct lease blocks (Viosca Knoll Block 916, Garden Banks Block 516, Garden Banks Block 602, and Mississippi Canyon Block 292) during 2000–2002 (Fig. 2.1). Sediment PAH values ranged from 11.8 to 23,840 ng/g (with a mean of 801.5 ng/g). The mean PAH concentration across all deep-water sediment samples was 596 ng/g. Both of the MMS 2006 and 2009 studies measured numerous parameters in addition to sediment PAHs, including metals, meio/macrofauna, bacterial activity, and sediment toxicity.

5.4 Qualitative Observations of Oil

Fluorometers were deployed concurrently with CTD and dissolved oxygen sensors to delineate areas of potential sub-surface oil by detecting the presence of dissolved organic compounds in the water column or very finely dispersed oil droplets (generally <60 μm). The fluorometer does not identify specific compounds or distinguish the sources of organic material. However, the intensity of fluorescence is influenced by the presence of specific compounds and the excitation wavelength of the ultraviolet light source. Therefore, fluorometry is a screening tool that estimates the level of oil in the water, but it is not a standalone method for accurately measuring oil concentration.

Sub-surface monitoring in the near field around the wellhead initially identified the sub-surface plume as a relative increase in background fluorescence between 1100 m and 1300 m, measured with a Chromophoric Dissolved Organic Matter (CDOM) fluorometer. Fluorescence, though not a quantitative measurement of hydrocarbon concentration, was found to correlate very strongly with PAH concentrations in the deep water. The same study measured PAH concentrations in this layer around the wellhead of up to 189 ppb in May, resulting in large spikes in fluorescence intensity (Diercks et al., 2010). Fluorescence remained a valuable screening tool throughout the response, providing a rapid indication of potential dispersed oil in the water column. After the well was capped on July 15, the fluorometry signal began to attenuate. By September, many vessels began using the Chelsea Aquatracka, which was shown to be more sensitive for MC252 oil.

The R/V *Pisces* cruise that performed water sampling in late September near the wellhead also detected fluorometric anomalies (signal spike) at a depth consistent with previous observations of the sub-surface plume using an Aquatracka. As per OSAT Recommendation 2 (September 20, App. F.1), the R/V *Pisces* returned to the area to collect water samples for chemistry measurements. As of the writing of this report, the analytical chemistry results from this cruise were still not published to the Scribe database. However, preliminary communication with LSU labs (Scott Miles, pers. comm.) indicated that all PAH samples were below detection limits. Thus, it appears that PAH concentrations have significantly decreased around the wellhead since the previous sampling in mid-July, when exceedances of benchmarks were still being observed.

Response sediment sampling in deep-water zone was primarily conducted using a multi corer on the vessels R/V *Gyre* and R/V *Ocean Veritas*, with a smaller number of samples collected using a grab sampler. In total, for the deep-water zone, qualitative results from multi corer sampling were obtained for 64 sediment samples from the R/V *Gyre* and 56 samples from the R/V *Ocean Veritas*, for a total of 120 samples (Fig. 5.2). These samples were analyzed for qualitative indications of oil, including both visual and olfactory inspection. Based on qualitative indicators, 29% of the 115 deep-water sediment samples showed potential indication of contamination by oil. Note that based on *quantitative* results 6% of the 115 sediment samples exceeded aquatic life benchmarks, as will be discussed in Section 5.7. Qualitative comments of possible oil contamination ranged from "thin layer of oil sheen on supernatant water surface" to "oil in sediment with slight oil smell." Example pictures are shown (Fig. 5.3) of R/V *Gyre* sediment cores for which MC252 oil was confirmed in the sample. A fluffy, brown, flocculated layer was reported in the upper part of some cores, which differs in color from the grayer drilling muds. This flocculated layer likely includes contributions from organic detritus sinking out of surface waters, including for example, algal flocs and zooplankton fecal material. Historical data from MMS (2003) similarly shows an upper flocculated layer in sediment cores in Viosca Knoll, next to Mississippi Canyon.

Qualitative observations from two academic cruises were also reviewed by the OSAT (Fig. 5.2). Note that, as of this report, quantitative sediment results from these academic cruises were not yet available, so qualitative assessments of oil have not been fingerprinted. Dr. Samantha Joye (UGA) shared qualitative results with the response from the R/V *Oceanus* academic cruise (21 August to 16 September; Fig. 5.2). They found indications of oil at 10 of the 14 sites they sampled, with thicker layers of potential oil-entrained sediments found all the way out to 37 km from the wellhead. Dr. Kevin Yeager (USM) was chief scientist on the R/V *Cape Hatteras* academic cruise (10-17 October; Fig. 5.2) that also collected sediment samples. He teleconferenced with the OSAT and discussed qualitative results from their samples. They observed 6 stations within ~20 km of the wellhead with some indication of oil (fingerprinting pending). The two stations with particularly strong indications of oil were within 5 km of the wellhead. All samples indicated that oil was sediment-entrained and not in liquid form (free-phase). Response sampling conducted under the Operational Annex re-visited many of these sampling sites between 22 September and 23 October. Sediment samples collected on these response cruises found MC252 oil present at levels of concern (i.e., levels that exceed aquatic life benchmarks) extending as far as 3 km from the wellhead (Section 5.7). The aquatic life ratios approach reference levels within ~10 km from the wellhead.

A recent NOAA-BOEMRE cruise on the NOAA Ship *Ronald H. Brown* from 14 October to 4 November noted stressed deep water coral at a location approximately 11 km southwest of the wellhead location. As part of the response Implementation Plan, sediment cores were taken that surrounded both the wellhead location and the stressed coral location. Although there were detectable oil-related compounds in the sediments of that immediate area, concentrations of oil-related compounds in these samples did not exceed aquatic life benchmarks (Fig. 5.2).

Fig 5.2. Location of multi corer sediment samples collected by the response. "Oil present" in the legend refers to positive qualitative (visual and/or olfactory) observations of oil. Qualitative results from two academic cruises (R/V Cape Hatteras and R/V Oceanus) are also shown. Analytical data collected during the response indicate exceedances of aquatic life benchmarks in sediment within approximately 3 km of the wellhead.

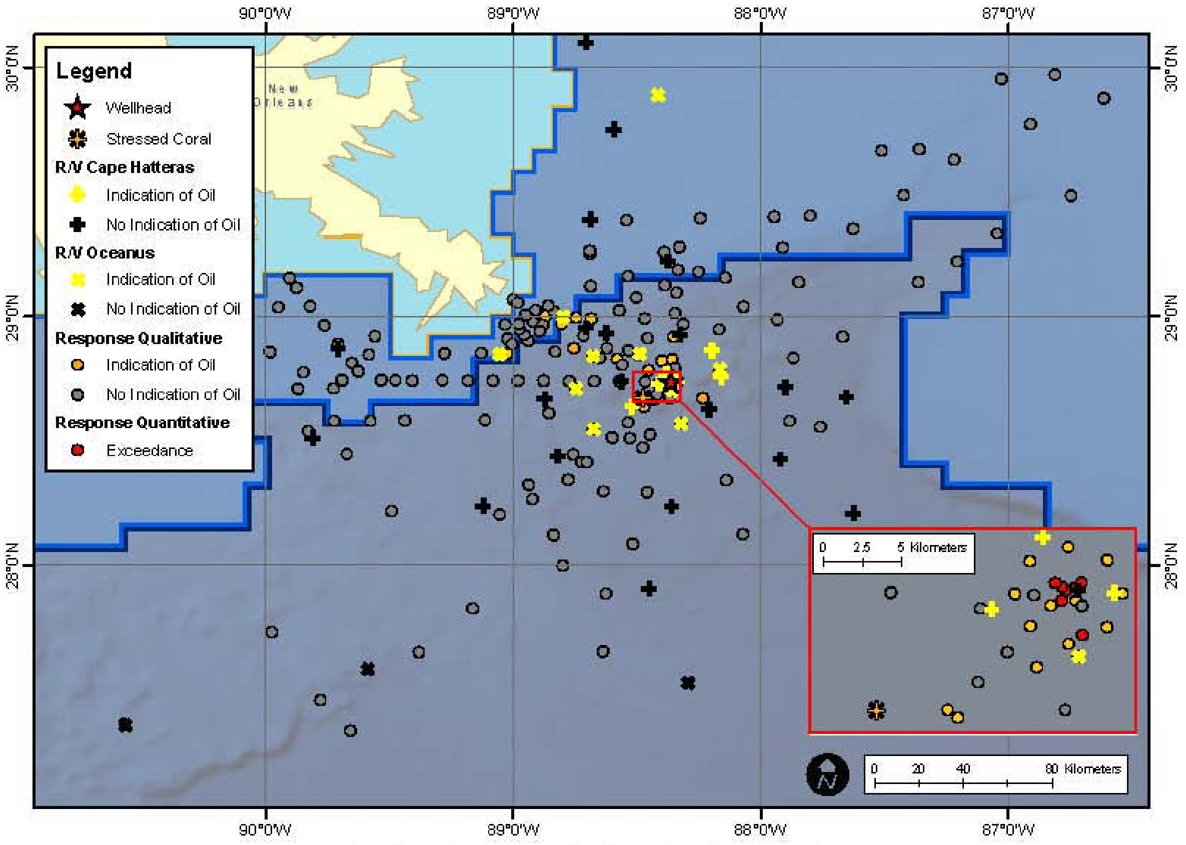
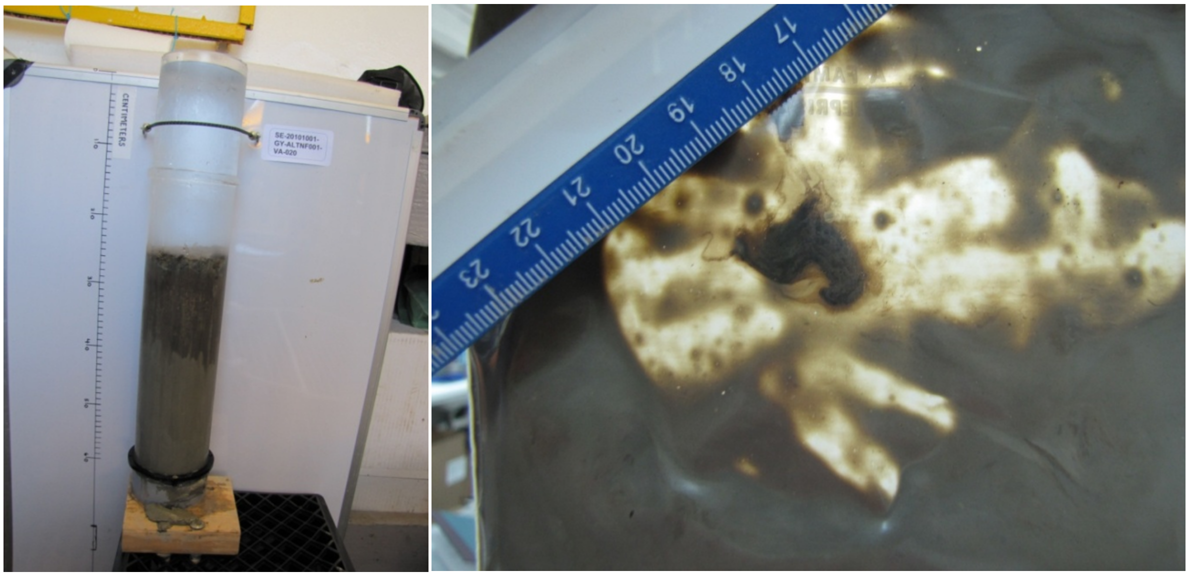


Figure 5.3. Pictures of sediment samples collected by the R/V Gyre near the wellhead. These samples were confirmed to contain MC252 oil. The sample IDs are SE-20101001-GY-ALTNF001-VA-020 (left panel), which shows the sediment depth profile, and SE-20101001-GY-NF006MOD-VA-021 (right panel), which shows extruded sediment (into a plastic bag) containing oil from the top 3 cm of the core.



5.5 Hypoxia

Dissolved oxygen data collected from 8 May to 9 August was analyzed and discussed by the Joint Analysis Group (JAG) (Report 3, 16 August). They reported significant dissolved oxygen depressions relative to background concentrations (minimum dissolved oxygen concentration observed was 3.7 mg/L in late July; depressions ranged from 0.14 mg/L to 3.7 mg/L below background). These dissolved oxygen depressions occurred coincident with relative maxima in fluorescence profiles used to screen for hydrocarbons and extended as far as 80 km from the wellhead. However, as dissolved oxygen concentrations were not approaching hypoxic levels (<2.0 mg/L) and did not appear to be decreasing over time, their analysis indicated that hypoxic conditions would not occur in association with the deep dispersed plume.

From 3 August through early October, numerous vessels sampling the plume responded to mission guidance, i.e., results were reported on dissolved oxygen depressions on a real-time (daily) basis. These measurements were made using an *in situ* oxygen sensor on the CTD (CTD/O_2). The accuracy of these sensors was calculated in the AOML Oxygen Report (2010) which demonstrated that the CTD/O_2 sensor and validation by Winkler's titration method were accurate to within 2%. Response sampling since 3 August resulted in a comprehensive delineation of the plume to the southwest. The minimum dissolved oxygen value measured since 3 August was ~4 mg/L, a depression relative to climatological background of <0.3 mg/L (JAG Oxygen Report, 2010). Stations revisited around the wellhead in October showed no measurable oxygen depressions.

5.6 Comparisons to Aquatic Life Benchmarks

In the deep-water sampling zone, the majority of the samples (~90%) were analyzed for the full suite of analytes (parent PAHs and alkylated PAHs). However, in a subset of these samples (~30%), the analyses for the volatile organic compounds (e.g. benzene, toluene, ethylbenzene and xylene) were given a different sample name and it was not possible to match up the samples within Scribe and hence these compounds were not included in the aquatic life ratio calculation (for more information on this issue and its implications see Appendices C.1 and C.5, respectively). A number of samples (roughly 1000) early in the response were analyzed only for BTEX compounds. Data from each sample that exceeded the benchmark for aquatic life in either the water or the sediment was examined in detail to confirm the validity of the exceedance and to assess the likelihood that the exceedance was due to MC252 oil (see Appendix D for methodology).

In the deepwater sampling zone there was a total of 70 exceedances of aquatic life benchmarks in water and 7 exceedances in sediment. Total aquatic life benchmark exceedances for PAHs in water and sediment represented ~2% of all samples collected (Table 5.1).

Table 5.1. Summary of water and sediment analytical chemistry results in the deep-water zone. Datasets were compared to benchmarks for human health, aquatic life, and dispersant chemicals. For each benchmark, total numbers of samples that were non-detect, below benchmark, or that exceeded the benchmark were computed. The total number of samples is not the same for the human health, aquatic life, or dispersant analyses because not all samples were analyzed for all analytes.

Sample Type	Indicator Level	Human Health	Aquatic Life	Dispersant
Water Column	Non-detect	4121	2721	3761
	Below Benchmark	673	821	353
	Exceed Benchmark	**0(0)***	**70(63)***	**0**
Sediment	Non-detect	n/a	6	119
	Below Benchmark	n/a	114	1
	Exceed Benchmark	**n/a**	**7(7)***	**n/a**
Total Samples		**4794**	**3739**	**4234**
Total Exceedances		**0**	77(70)	**0**
Percent of Exceedances		**0%**	**2%**	**0%**
Total Exceedances After 3 August		**0**	**7(7)**	**0**

*The # in parentheses refers to exceedances consistent with MC252 oil.

The chronic aquatic life ratios in water samples decreased with distance from the wellhead (Fig. 5.4). Chronic exceedances potentially associated with MC252 oil were constrained to within approximately 70 km of the wellhead in deep water (Fig. 5.4; Map 7.4a). No exceedances consistent with MC252 oil were observed in the period post-August 3 (Fig. 5.5; Map 7.4b). The last exceedance consistent with MC252 oil was observed on 22 July at a depth of 1,140 m.

Exceedances of the chronic aquatic life benchmark were generally observed at two depth ranges throughout the water column. The highest aquatic life ratios were associated with surface or near-surface water. Exceedances were also observed in the water column at the depth range from 1100 m to 1300 m (Fig. 5.6), consistent with the qualitative observations of the deep plume of dispersed and dissolved oil.

A total of 16 samples also exceeded the acute toxicity benchmark in the deep-water sampling zone. All of these occurred prior to mid-July.

Figure 5.4. Chronic aquatic life ratios as a function of distance from the wellhead. The horizontal dotted line represents the chronic aquatic life benchmark of 1.

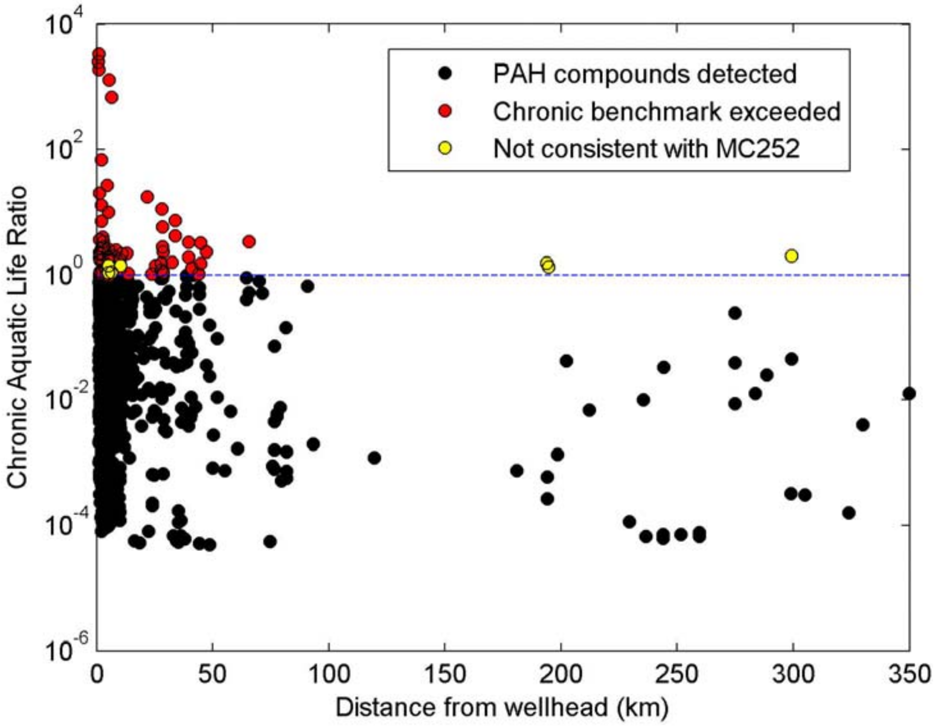


Figure 5.5. Chronic aquatic life ratios as a function of time. The horizontal dotted line represents the chronic aquatic life benchmark of 1.

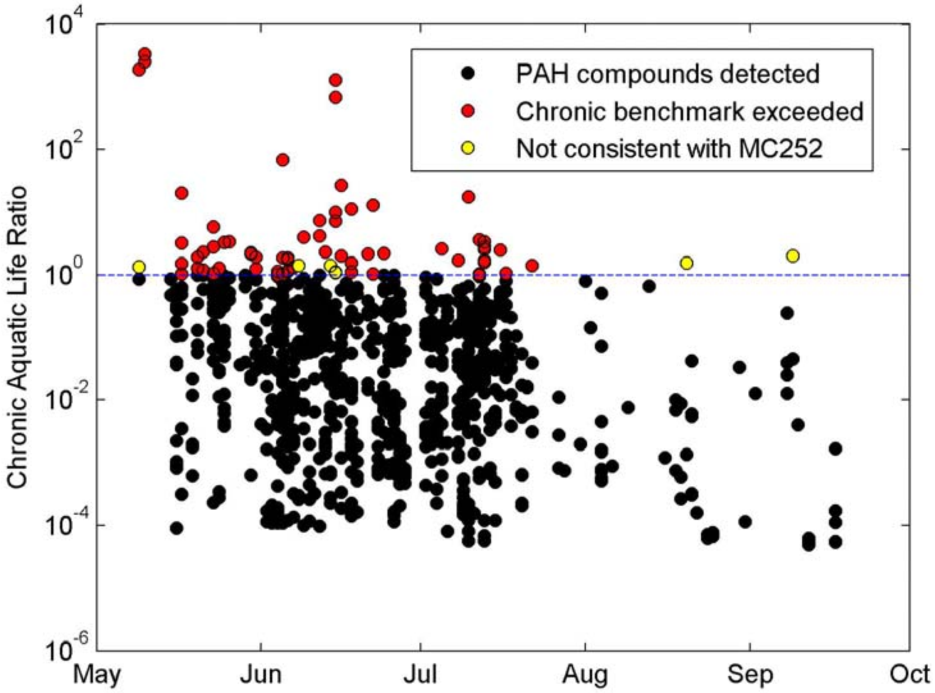
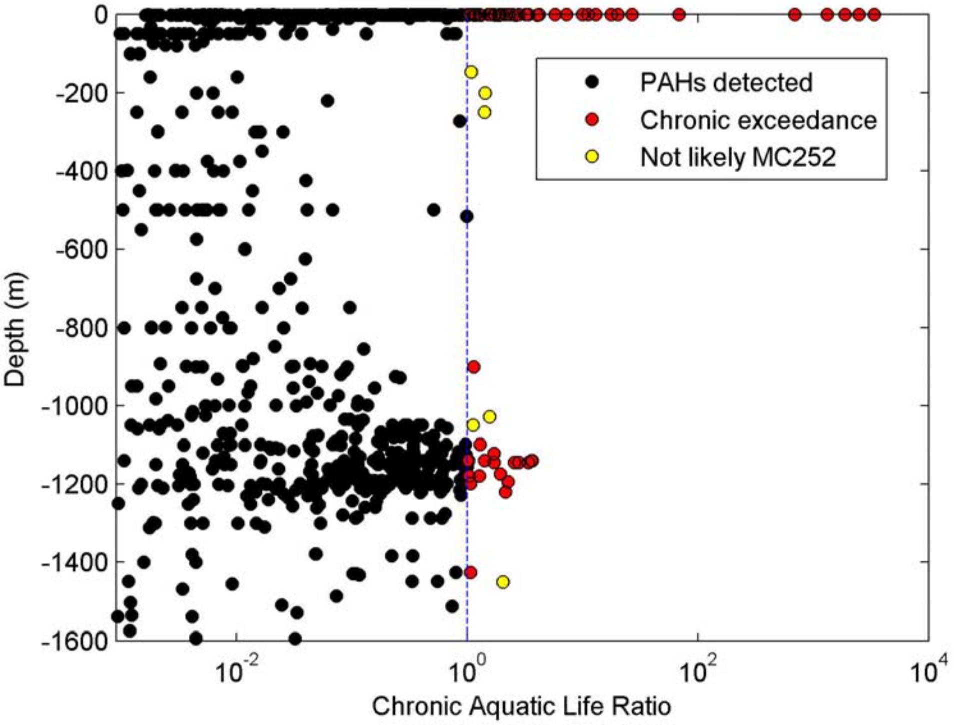
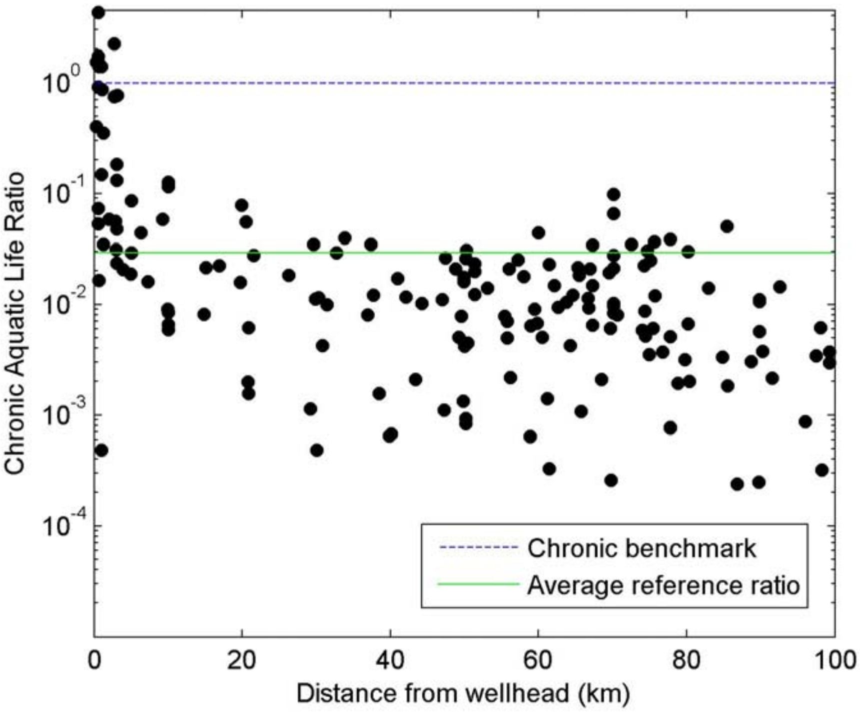


Figure 5.6 Chronic aquatic life ratios as a function of depth. The horizontal dotted line represents the chronic aquatic life benchmark of 1.



All sediment samples collected in the deep-water zone were collected as part of the Operational Annex (Maps 7.5a,b). Samples were compared to EPA's aquatic life benchmarks for sediments. Seven samples were found to exceed the chronic benchmark (Table 5.1; Fig. 5.7). One of the sediment samples also exceeded the acute benchmark. Samples that exceeded sediment benchmarks were all located within the range of 0.33-2.7 km of the wellhead and were all confirmed to be consistent with MC252 oil (Table 5.2; Figure 5.7). The absolute concentrations of total PAHs were 9,900 ng/g to 28,000 ng/g.

Figure 5.7 Sediment chronic aquatic life ratios as a function of distance from the wellhead. The blue horizontal dotted line represents the chronic aquatic life benchmark. The green horizontal line represents the average chronic ratio at deep-water reference stations.



Chronic aquatic life ratios for sediment samples were also compared to ratios for reference locations in the deep water. These historical, reference studies included two MMS studies (Continental Shelf Assoc., 2006; Rowe and Kennicutt, 2009). The average chronic aquatic life ratio at these deep water reference stations ranged from 0.0011 – 0.33, with an average of 0.029 across all stations. In comparison to the average chronic ratio at reference stations, the chronic ratio for response samples were (on average) at or below the reference value beyond 10 km from the wellhead (Fig. 5.7). Thus, chronic aquatic life exceedances were observed within 3 km of the wellhead, but samples above reference levels were observed out to 10 km from the wellhead.

Source characterization of exceedances

A vast majority of the samples that exceeded the chronic aquatic life benchmark were either indeterminate in origin (given lack of data) or were consistent with MC252 oil. A portion of these exceedances were from the DEEP program (Appendix E), all of which were consistent with MC252 oil. The 7 samples that were considered not consistent with MC252 oil fell into one of the following categories: consistent with diesel range oil (likely caused by other sources), consistent with pyrogenic PAHs, or consistent with seep sources (see Appendix D).

The one water sample that was associated with a seep source (SW-20100909-OV19-12) was collected on 9 September in 1450 m of water at a distance of 299 km from the wellhead. The GC/MS Extracted Ion Current Profiles (EICPs) indicated the presence of crude-oil- related hydrocarbons. The abundance and distribution of the triterpanes and steranes are substantially different from MC252 oil, which demonstrates that MC252 oil is likely not the source of the hydrocarbons in this sample. The overall distribution of hydrocarbons suggests that the petroleum in this sample may be related to seep oil. This result was corroborated by preliminary data provided by NOAA's analyses that indicate that this sample is near a known seep area.

The 7 sediment samples that exceeded benchmarks were confirmed to be consistent with MC252 oil based on an analysis of the chromatograms. The samples IDs for these are preceeded by "SE" in Table 5.2. These deep-water samples were all collected within 3 km of the wellhead. There were also indications of drilling mud compounds in these samples based on 3 parameters: (1) higher barium levels than area sediments, (2) the presence of C16 and C18 alpha olefins (synthetic drilling mud additive), and (3) presence of relatively unweathered crude oil. Oiled sediment samples were not weathered to the same extent as oiled water samples in surface waters. For example, SE-20101001-GY-ALTNF001-020 lost its gasoline range organics through C10-11, and SE-20101001-GY-NF006mod-022 lost them through C12. Most of the sediment exceedance samples showed PAH depletion of 4-8% and a few were as high as 57–75%.

Table 5.2. List of aquatic life benchmark exceedances for water and sediments in the the deep-water zone after 3 August. Details are listed for each exceedance including the source of the oil, identified as follows: (1) consistent with MC252 oil, (2) not consistent with MC252 oil, and (3) indeterminate. Highlighted rows indicate sediment samples; non-highlighted rows indicate water samples.

Sample Date	Type of Exceedance	Sample Location	Sample ID	Source
8/20/2010	Chronic	27.1512, -88.1777	SW-20100820-OV15-004	2
9/9/2010	Chronic	26.8251, -90.5024	SW-20100909-OV19-012	2
10/1/2010[1]	Chronic	28.7347, -88.3705	SE-20101001-GY-ALTNF001-HC-021_BDO	3
10/1/2010	Chronic	28.7347, -88.3705	SE-20101001-GY-ALTNF001-HC-020_BDO	1
10/1/2010	Chronic	28.7451, -88.3591	SE-20101001-GY-NF006MOD-HC-022_BDO	1
10/17/2010	Acute	28.7150, -88.3587	SE-20101017-GY-D031S-HC-050_BDO	1
10/17/2010	Chronic	28.7404, -88.3681	SE-20101017-GY-D038SW-HC-053_BDO	1
10/17/2010[2]	Chronic	28.7449, -88.3742	SE-20101017-GY-D044S-HC-055	1
10/17/2010	Acute	28.7423, -88.3622	SE-20101017-GY-D040S-HC-052_BDO	1
10/17/2010	Chronic	28.7425, -88.3705	SE-20101017-GY-D042S-HC-054_BDO	1

[1] This sample was removed from consideration because it is a field duplicate.

[2] When the actual TOC is used for this sediment sample (versus an assumed 1%), it becomes an exceedance.

5.7 Comparison to Dispersant Benchmarks

Deep-water samples were analyzed for the dispersant-related chemicals 2-Butoxyethanol, DPnB, and Propylene Glycol (Appendix A, Table A-1). Screening levels exist for dispersant compounds in water only.

The dispersant-related chemical measures predominantly in the deep-water zone was DPnB. The benchmark for DPnB in water is 1,000 µg/L (1 ppm). Of the 4114 total samples that were analyzed for dispersants in the water column, 353 samples contained measurable amounts of DPnB. The range in detected DPnB concentrations was 0.0170 – 113.4 µg/L (mean 4.3 µg/L), with all samples significantly below the chronic screening level (Fig. 5.8). Concentrations of DPnB decreased with time, with all values less than 5 µg/L by July 30. Peaks in DPnB detects were observed in two distinct layers, at the surface and in the sub-surface (1100 to1300m; Fig. 5.9) similar to distributions of exceedances of the aquatic life benchmark for PAHs.

Figure 5.8. Concentrations of the dispersant DPnB in water samples versus time.

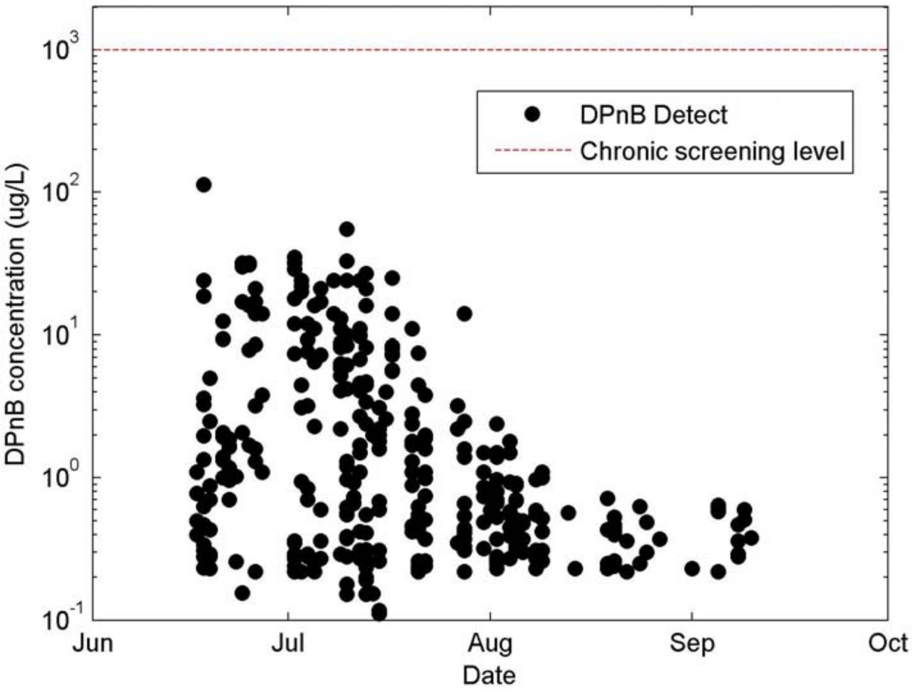
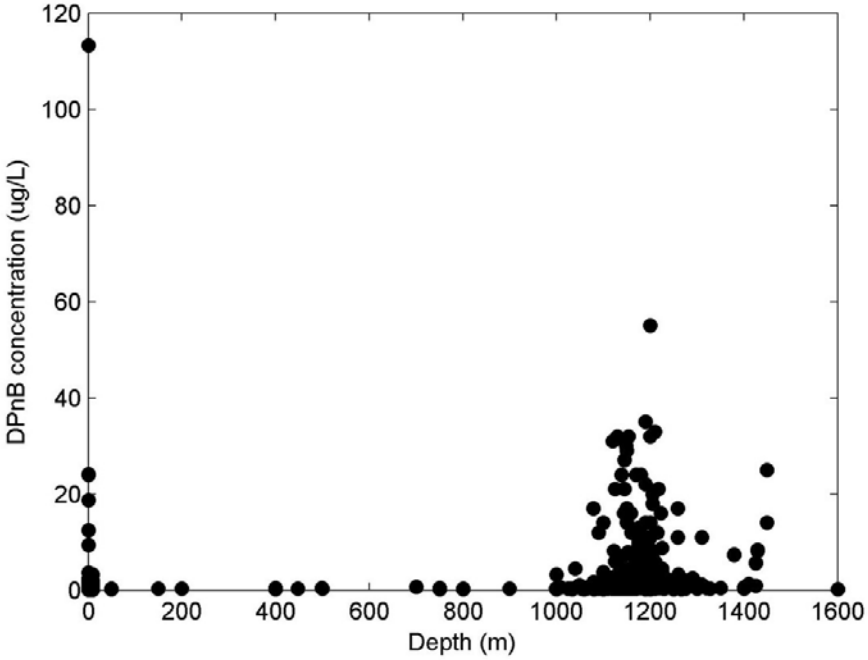


Figure 5.9 Concentrations of DPnB versus depth.



5.8 Biodegradation

Measurements of the microbial community, including both community structure and biodegradation, have been an important topic of research during the DWH oil spill. Many of these studies have been funded through academia, with some support from the response. For example, Dr. David Valentine's (UCSB) microbial sampling on the R/V *Pisces* (9/8/2010 – 9/17/2010) was coordinated with John Kessler's chemistry sampling which is being funded by the Response. However, Valentine's post-cruise laboratory analyses are being funded by multiple sources, and that data will not be available for a couple of months. Several different researchers and their respective science teams have been involved in academic microbial sampling missions, including Dr. Terry Hazen (LBNL), Dr. David Valentine (UCSB), Dr. Andreas Teske (UNC-Chapel Hill), Dr. Richard Camilli (WHOI), and Dr. Samantha Joye (UGA). Much of this work has not yet been published. As well, the JAG Oxygen Report (2010) discusses factors affecting biodegradation of deepwater hydrocarbons and modeled the impact biodegradation could have on the time required to reach hypoxia in the deep sea.

The OSAT reviewed published literature for the DWH oil spill to enhance our understanding of oil biodegradation. Microbial analyses in Hazen et al. (2010) were performed on water samples collected from vertical casts near the wellhead in late May and early June. Hazen's team provided evidence that a large number of bacterial genes involved in hydrocarbon degradation were significantly increased in sub-surface oil plume samples. Total bacterial densities were also significantly correlated with MC252 alkane concentration in the plume. Hazen's group measured 16S rRNA gene sequences in bacteria from the plume and found that they were dominated by the order Oceanospirillales in the γ-proteobacteria. The presence of this order was unique to the deep-water plume and this order was not present above or below it. Hazen's group calculated maximum biodegradation rates based on concentrations of C13-C26 n-alkanes, resulting in half-lives ranging from 1.2 to 6.1 days that were similar for both field and microcosm conditions . Previous laboratory studies using crude oil and dispersants (including COREXIT 9500) showed rapid loss of dispersed oil in the sea by biodegradation (Venosa and Holder, 2007).

Biodegradation rates will necessarily vary as the sub-surface plume ages, and the most labile components of the oil are degraded, leaving behind the recalcitrant fractions. Hazen's rates indicated that the least recalcitrant fraction (alkanes) of the oil would persist for only weeks. The degradation rates for the complete mixture of compounds that characterize MC252 oil have not yet been determined.

Estimates of oil biodegradation have also been made using changes in dissolved oxygen concentrations measured in the sub-surface plume, based on the premise that bacterial degradation of oil is expected to cause consumption of dissolved oxygen. Camilli et al. (2010) estimated bacterial respiration based on temporal changes in dissolved oxygen concentration in the sub-surface plume. Their work was based on samples collected farther away from the wellhead and at a later date (i.e., late June) compared to the Hazen study. The results of Camilli et al. (2010) suggested that microbial respiration rates within the plume were not appreciably more than 1 μM O2 day^{-1}, such that minimal biodegradation was occurring in the remaining plume, which included monoaromatic hydrocarbons, such as BTEX. The JAG Oxygen Report (2010) also estimated biodegradation of oil in the plume using various techniques for estimating biochemical oxygen demand. They estimated a first-order biodegradation rate constant of 0.0054/d as a lower bound on biodegradation estimates. The report estimated the possible time needed to reach hypoxia, assuming no replenishment of dissolved oxygen by mixing with oxygen-rich surrounding waters, ranged from 24 to 74 days. A shorter time of 1.3 days to hypoxia was estimated using using Hazen's high first-order biodegradation rate. Significantly, hypoxia was never observed in deep water during the incident.

In summary, the various microbial and chemical (i.e., oxygen) measurements made in the deep-water plume confirm that biodegradation of oil has been occurring. Estimates of biodegradation rates range from a lower bound of 0.0054/d estimated in the JAG oxygen report, which is likely more representative of the whole oil mixture, to an upper bound estimated by Hazen's group of 0.310/d for alkane biodegradation.

Section 6: Conclusions

The UAC's Operational Science Advisory Team (OSAT) concludes that sampling was adequate to address the presence and distribution of sub-surface oil (with the exception of very shallow nearshore areas where submerged tar mats may be present; discussed below). No deposits of liquid-phase MC252 oil were identified in sediments beyond the shoreline. Based on the analysis of extensive data in the nearshore, offshore, and deep water zones, the OSAT identified two areas of concern with respect to the indicators considered. Sediments exceed the aquatic life benchmark within 3 km of the well head and are above reference levels within 10 km and tar mats exist in some shallow sub-tidal areas near the shore.

Sediment PAH concentrations exceeded the aquatic life benchmark within 3 km (~2 miles) of the wellhead and were above reference concentrations within 10 km. The decision on whether or not this oil is actionable lies with the FOSC. The assessment of acute and long-term chronic effects to the Gulf of Mexico ecosystem is not within the purview of the response and is being addressed as part of the injury assessment conducted through the Natural Resources Damage Assessment (NRDA) process.

Observations from qualitative programs in the nearshore sampling zone indicate tar mats in sub-tidal nearshore areas are another area of concern. The sediment-bound oil within these subsurface tar mats could potentially be remobilized leading to the re-oiling of adjacent or neary-by shorelines. The sub-surface sampling plans did not entirely address this region due to difficulties with sampling in shallow water. Current efforts to address this issue within the UAC include continued monitoring by shoreline clean up and assessment teams (SCAT) and the formation of a specialized group at the UAC (OSAT II) to evaluate existing data and make recommendations for any additional sampling.

Other than these two areas of concern (sediments near the wellhead and near shore tar mats) the OSAT found:

- No deposits of liquid-phase MC252 oil in sediments.
- No exceedances of EPA's Human Health benchmark in water.
- No exceedances of EPA's dispersant benchmarks.
- Since 3 August, no exceedances of the aquatic life benchmark for PAHs in water that were consistent with MC252 oil.
- Since 3 August, no exceedances of the aquatic life benchmark for PAHs in sediment beyond 3 km of the wellhead that were consistent with MC252 oil.

The OSAT is confident that the quality of these data is sufficient to address the presence or absence of sub-surface oil and dispersants within the context of an operational emergency response evaluation. However, several factors should be considered in interpreting these findings for any other purpose.

- Sample detection limits varied. Because some analytes had very high detection limits, the treatment of “below detection” results (calculating them as zeros) has the potential to underestimate concentrations.

- Many of the aquatic life ratios used in the Aquatic Life Benchmark for PAHs are estimates. Since some calculations did not include contribution of volatile organic compounds, ratios may be underestimated in some circumstances. Some analyses did not include alkylated compounds. The use of a multiplier to adjust total concentrations could underestimate or overestimate concentrations.

- Reference concentrations do not represent “background” conditions. Concentrations of PAHs in reference samples do not represent clean or pristine conditions, but represent average concentrations in the zone of interest before the spill. Other sources of PAHs, including seeps, may be represented in these comparisons.

- Many TOC values used in calculating the Aquatic Life Benchmarks for PAHs for sediments are estimates because actual TOC values were often not available. Though a conservative TOC concentration was applied, this could underestimate or overestimate exceedances of sediment quality benchmarks for individual samples.

Section 7: Maps

Map 7.1: Sampling Zones

Map 7.2a: Sample Locations in Nearshore Zone Houma AOR

Map 7.2b: Sample Locations in Nearshore Zone Mobile AOR

Map 7.3: Sample Locations in Offshore and Deep-Water Zones

Map 7.4a: PAH Aquatic life Benchmark Analyses (Water Column) All Samples

Map 7.4b: PAH Aquatic life Benchmark Analyses (Water Column) Samples post 3 August

Map 7.5a: PAH Aquatic Toxicity Benchmark Analyses (Sediment) All Samples

Map 7.5b: PAH Aquatic Toxicty Benchmark Analyses (Sediment) Samples post 3 August

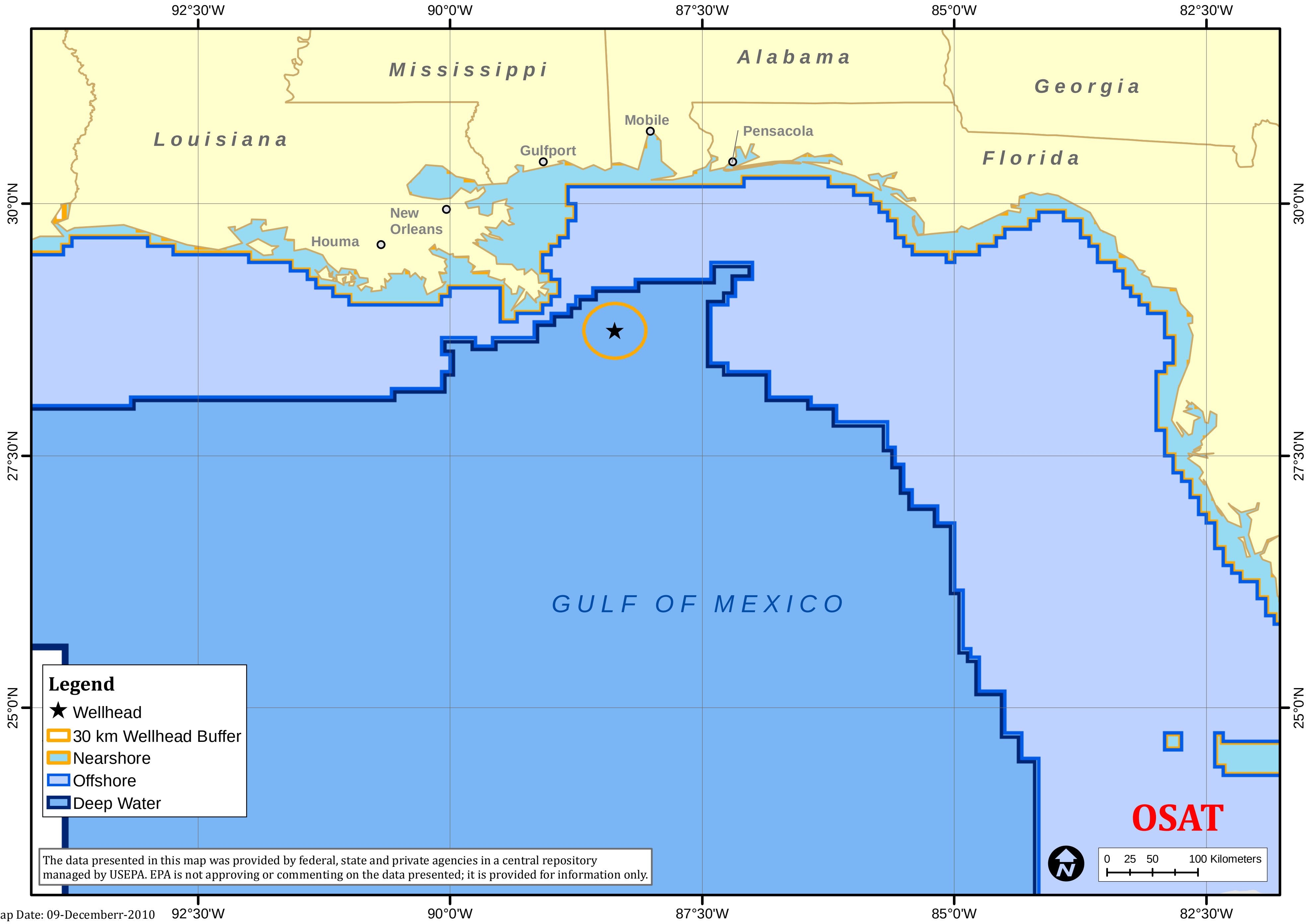
Map 7.6: Human Health Benchmark Analyses

Map 7.7: Dispersant Benchmark Analyses (Water Column)

Map 7.8: Dispersant Benchmark Analyses (Sediment)

Map 7.1: Sampling Zones

Deepwater Horizon Response, Gulf of Mexico



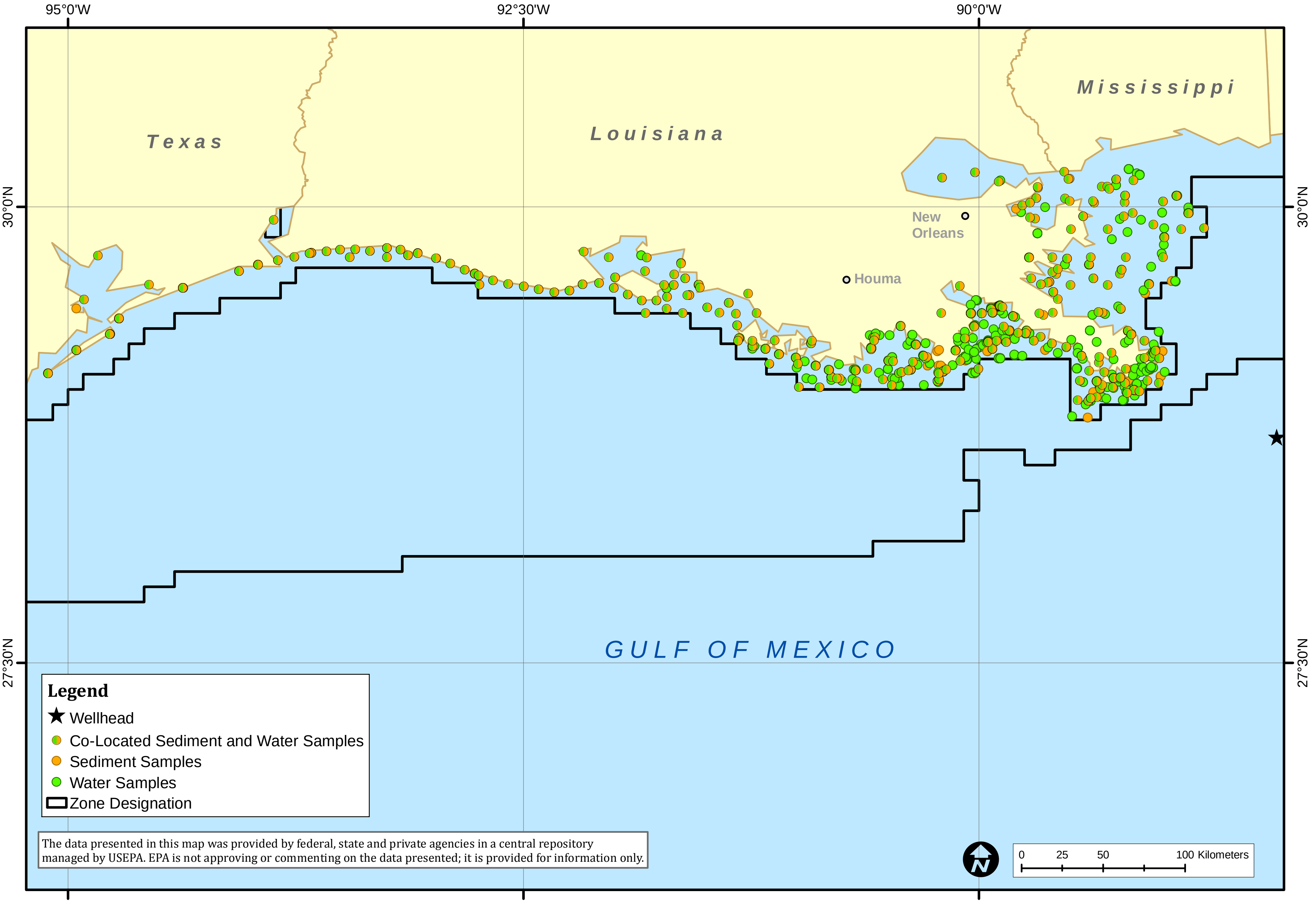
The data presented in this map was provided by federal, state and private agencies in a central repository managed by USEPA. EPA is not approving or commenting on the data presented; it is provided for information only.

Map Date: 09-Decemberr-2010

Map 7.2a: Nearshore Sample Locations - Houma AOR

Sample Dates: 30 April 2010 to 20 October 2010

Deepwater Horizon Response, Gulf of Mexico



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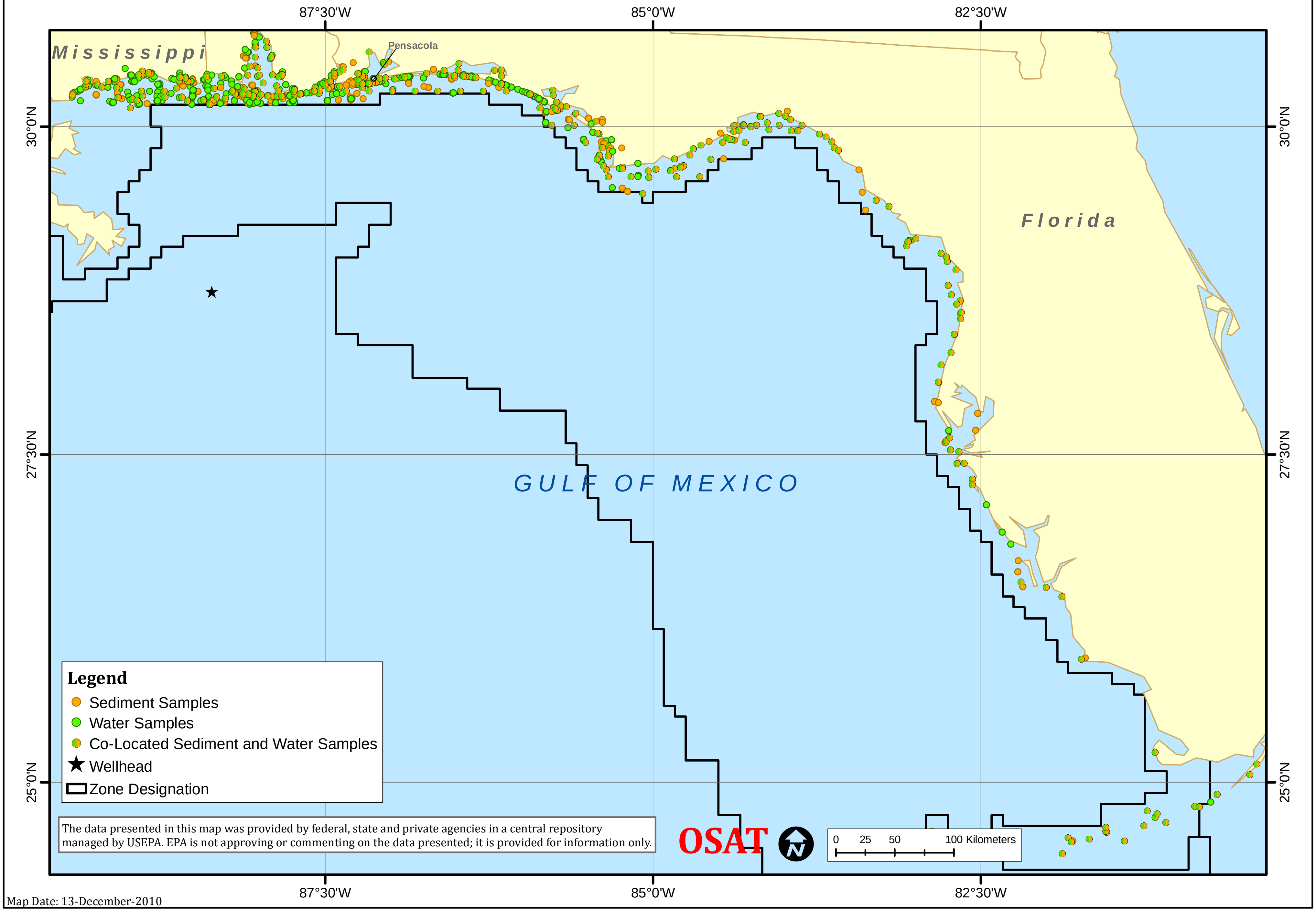
Map Date: 13-December-2010

Map 7.2b: Nearshore Sample Locations - Mobile AOR

Sample Dates: 30 April 2010 to 20 October 2010

Deepwater Horizon Response, Gulf of Mexico



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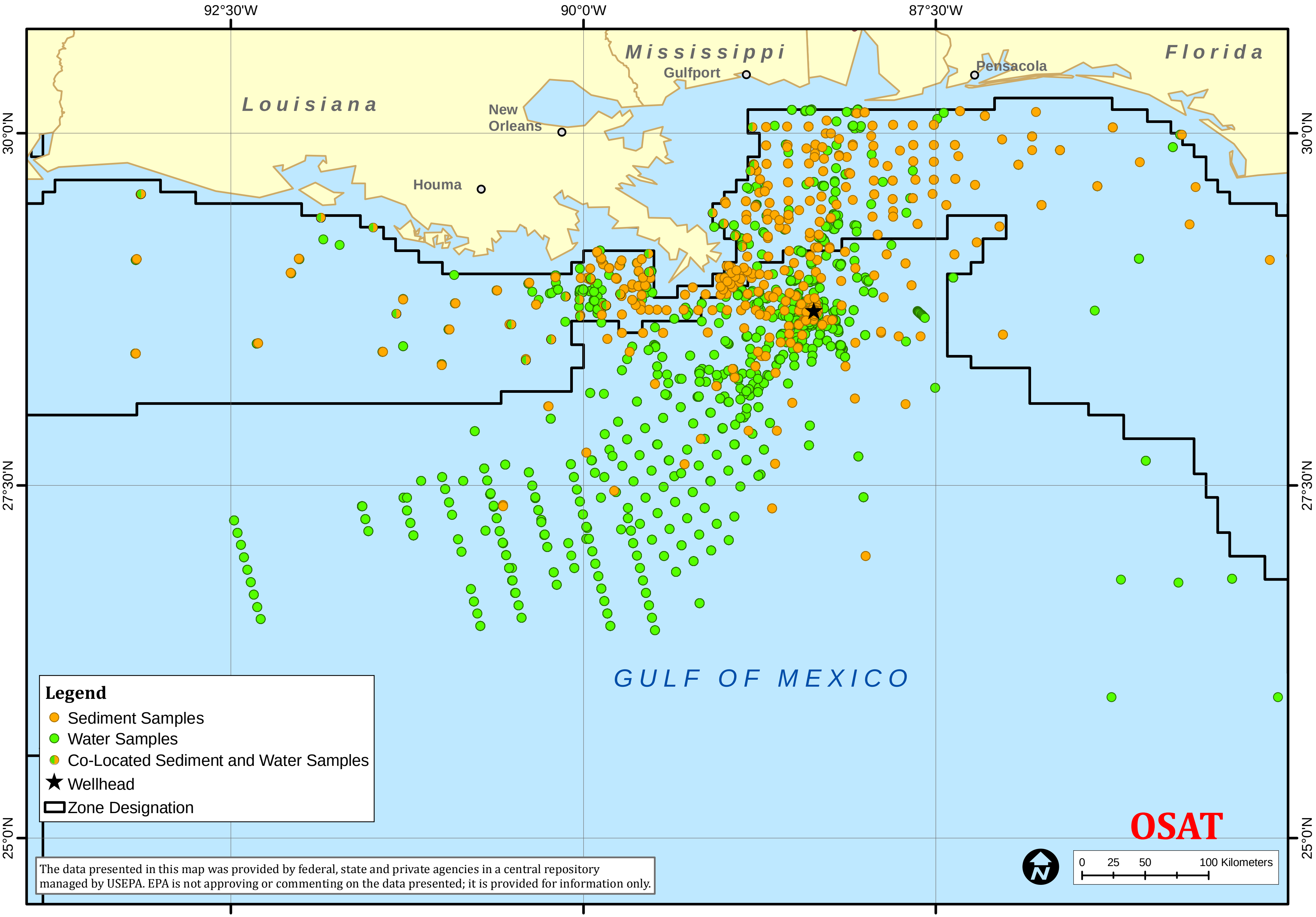
Map Date: 13-December-2010

Map 7.3: Offshore & Deep Water Sample Locations

Sample Dates: 28 April 2010 to 23 October 2010

Deepwater Horizon Response, Gulf of Mexico



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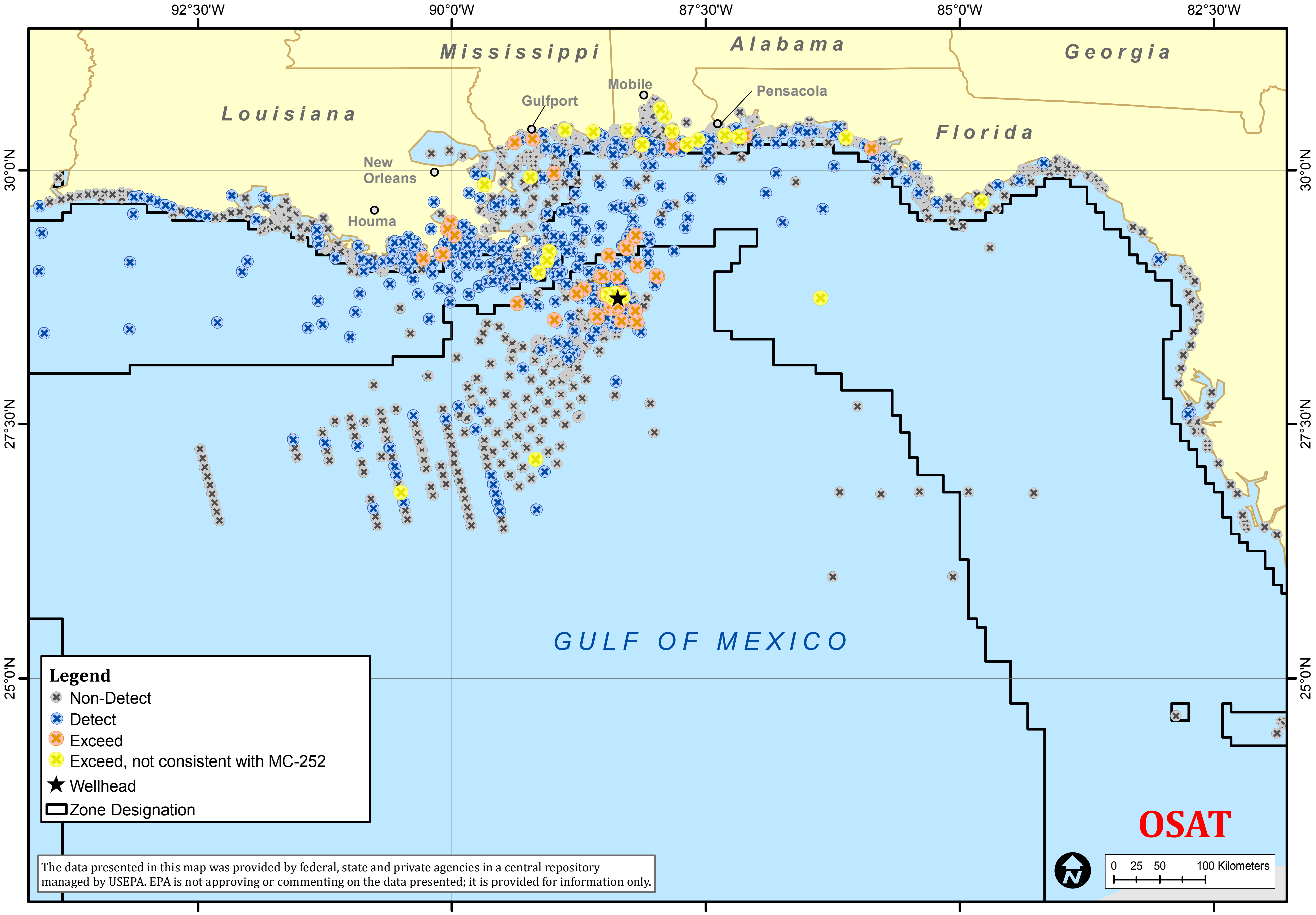
Map Date: 13-Decemberr-2010

Map 7.4a: PAH Aquatic Life Benchmark Analyses - All Water Samples

Sample Dates: 30 April 2010 to 18 October 2010

Deepwater Horizon Response, Gulf of Mexico



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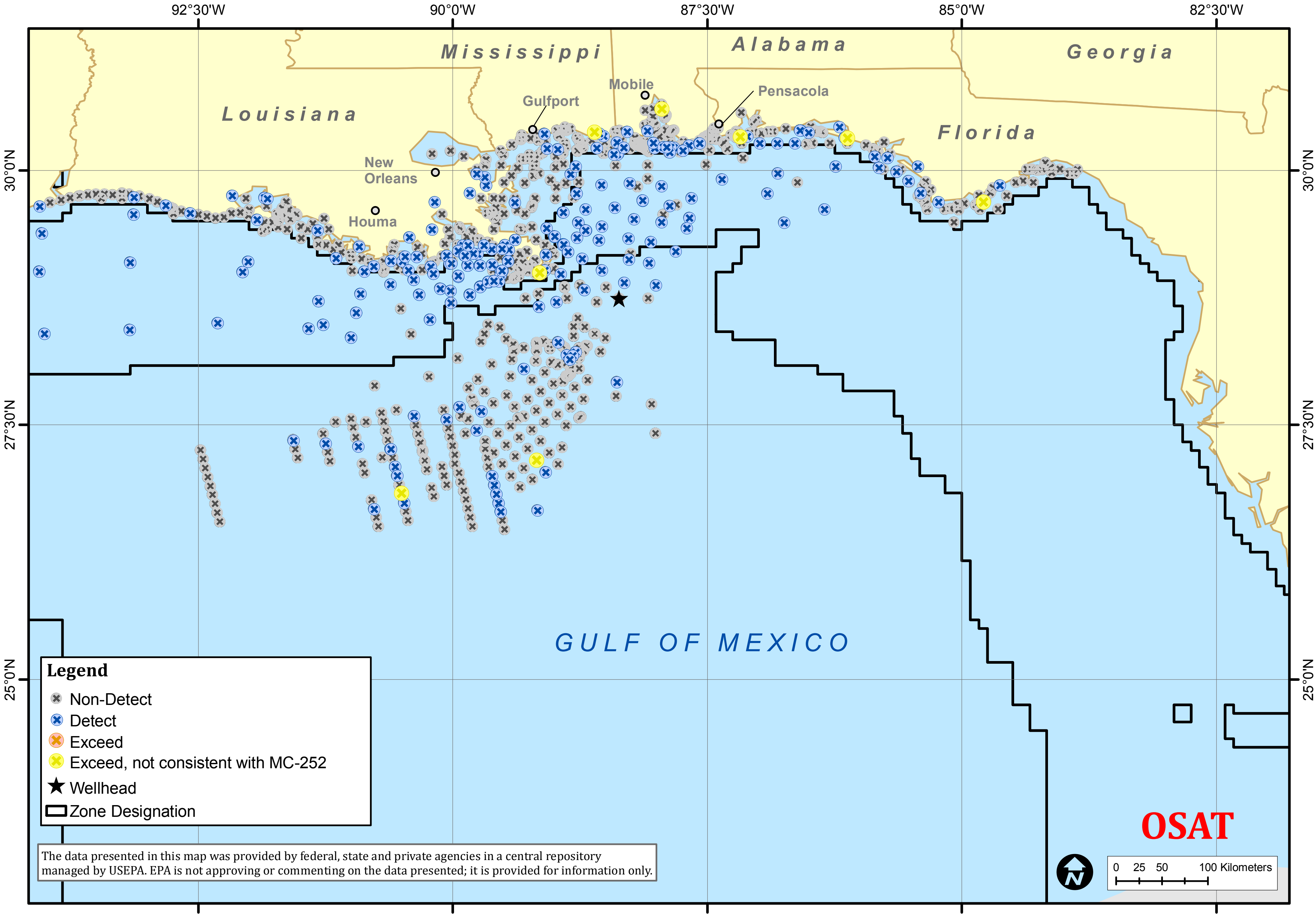
Map Date: 13-December-2010

Map 7.4b: PAH Aquatic Life Benchmark Analyses - All Water Samples Collected After 3 August 2010

Sample Dates: 4 August 2010 to 18 October 2010

Deepwater Horizon Response, Gulf of Mexico



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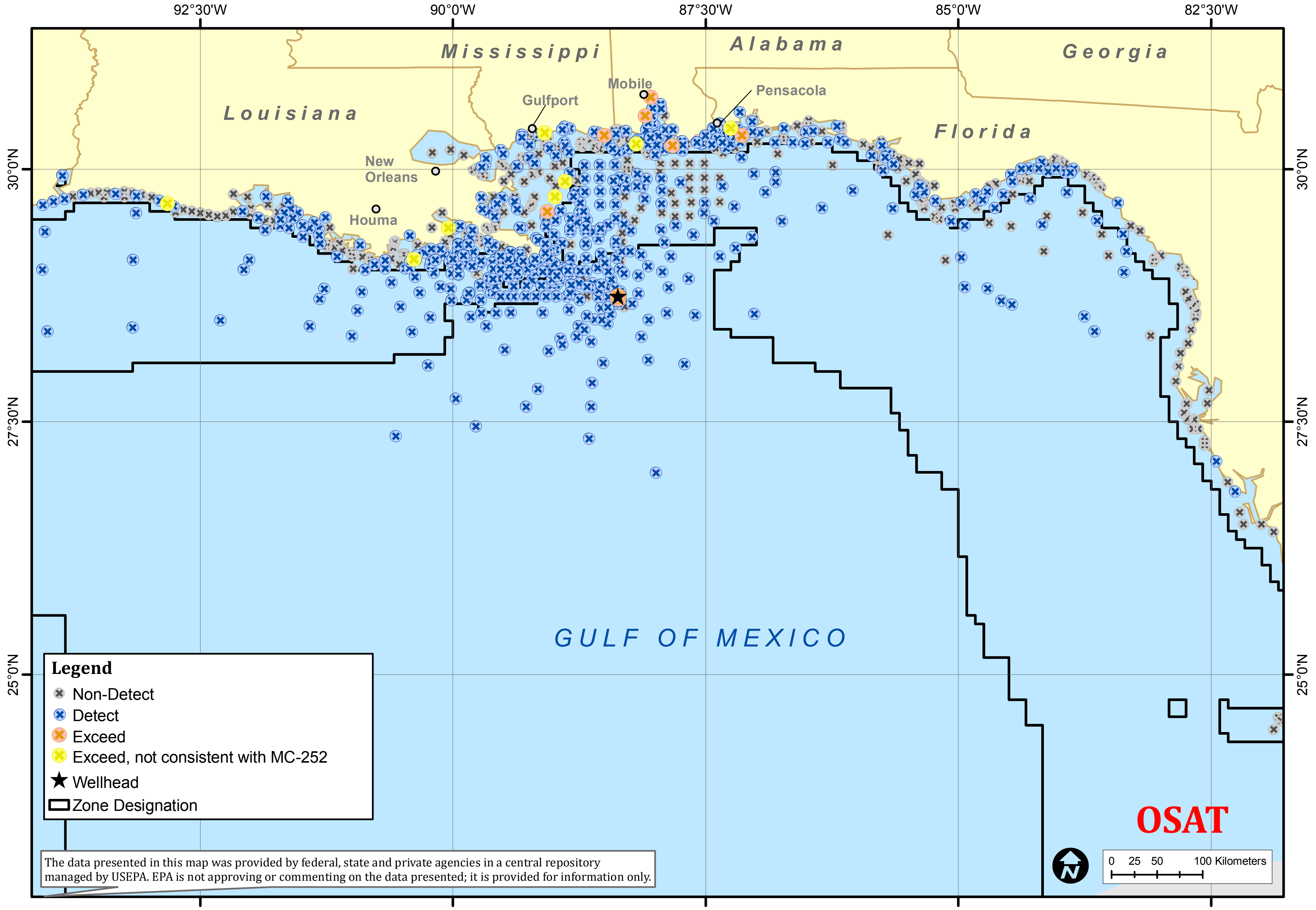
Map Date: 09-December-2010

Map 7.5a: PAH Aquatic Life Benchmark Analyses - All Sediment Samples

Sample Dates: 30 April 2010 to 23 October 2010

Deepwater Horizon Response, Gulf of Mexico



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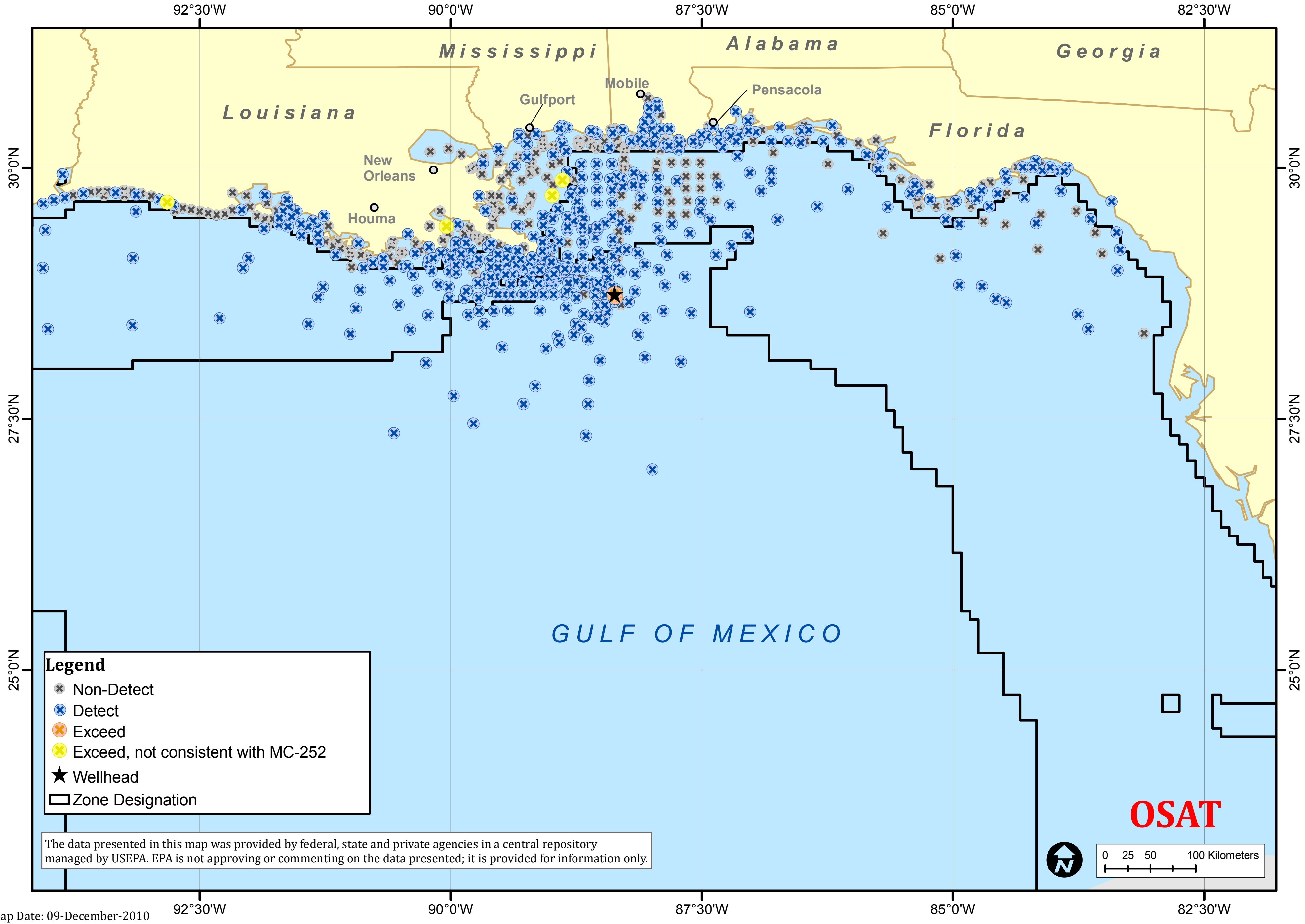
Map Date: 13-Decemberr-2010

Map 7.5b: PAH Aquatic Life Benchmark Analyses - All Sediment Samples Collected After 3 August 2010

Sample Dates: 4 August 2010 to 23 October 2010

Deepwater Horizon Response, Gulf of Mexico



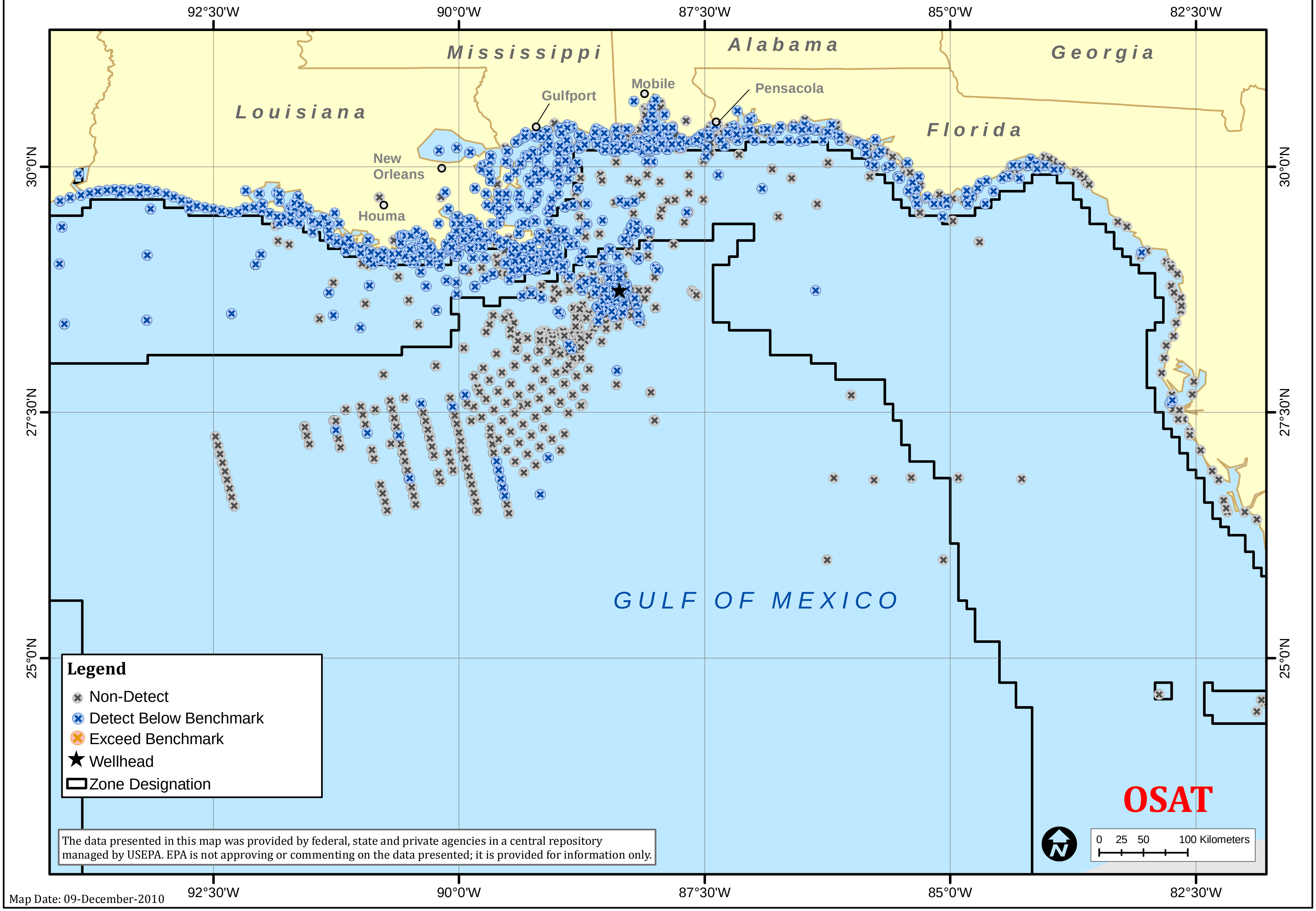
The data presented in this map was provided by federal, state and private agencies in a central repository managed by USEPA. EPA is not approving or commenting on the data presented; it is provided for information only.

Map Date: 09-December-2010

Map 7.6: Human Health Benchmark Analyses - All Water Samples

Sample Dates: 30 April 2010 to 18 October 2010

Deepwater Horizon Response, Gulf of Mexico



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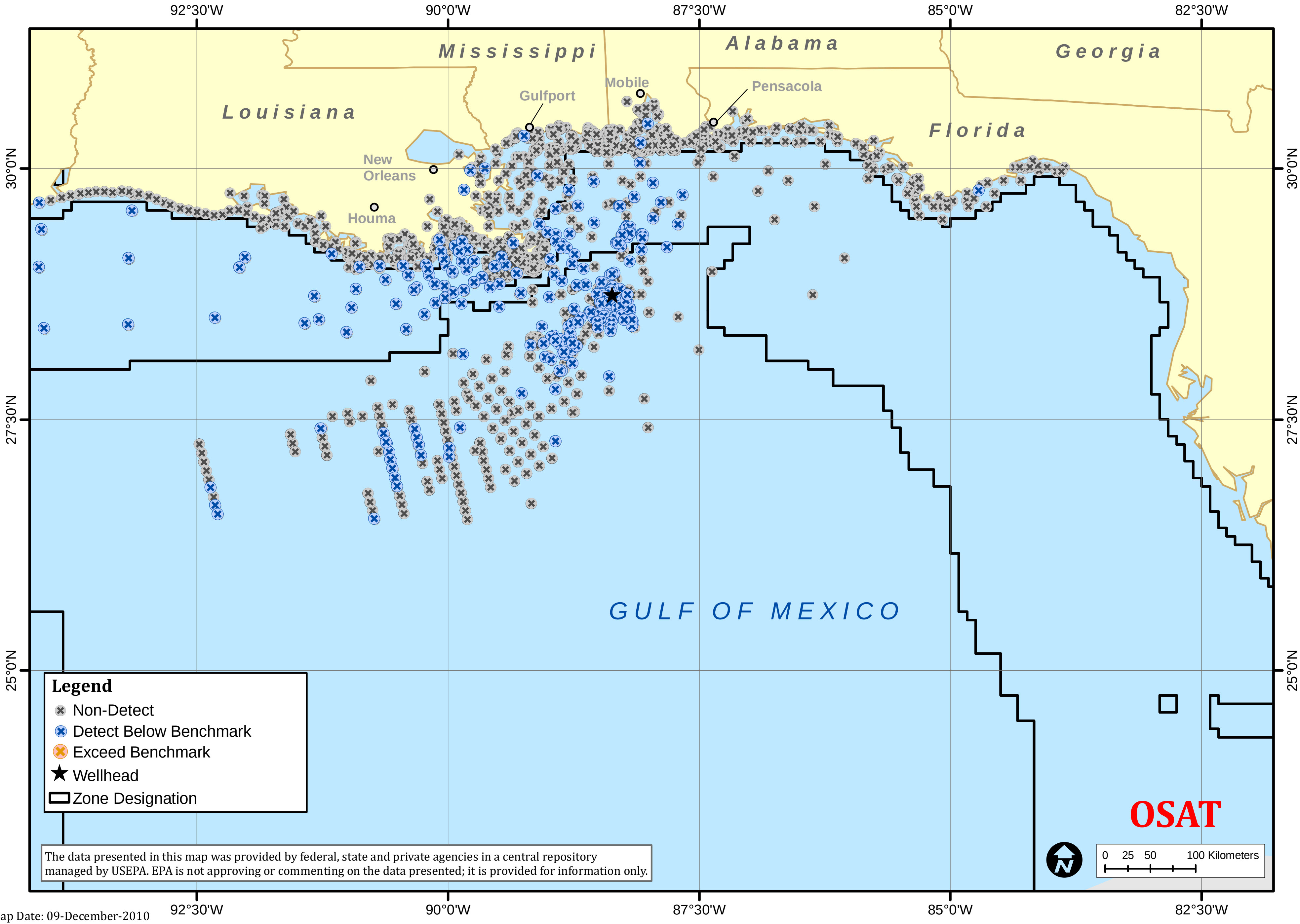
Map Date: 09-December-2010

Map 7.7: Dispersant Indicators - All Water Samples

Sample Dates: 5 May 2010 to 18 October 2010

Deepwater Horizon Response, Gulf of Mexico



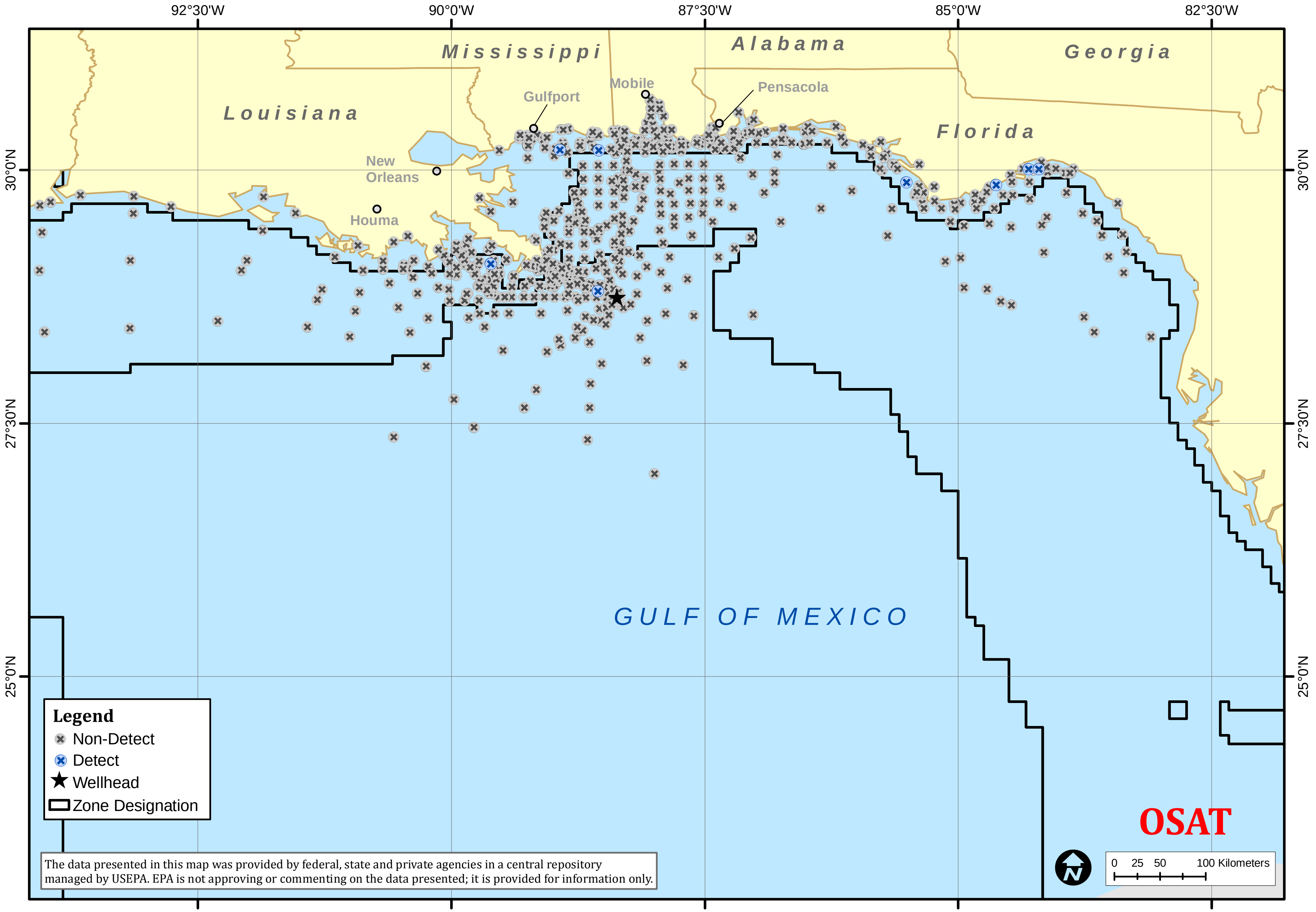
The data presented in this map was provided by federal, state and private agencies in a central repository managed by USEPA. EPA is not approving or commenting on the data presented; it is provided for information only.

Map Date: 09-December-2010

Map 7.8: Dispersant Indicators - All Sediment Samples

Sample Dates: 5 May 2010 to 23 October 2010

Deepwater Horizon Response, Gulf of Mexico



The data presented in this map was provided by federal, state and private agencies in a central repository managed by USEPA. EPA is not approving or commenting on the data presented; it is provided for information only.

Map Date: 09-December-2010

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Appendices

Appendices

Appendix A: Benchmark Calculations and Screening Levels

A.1 Dispersant Benchmarks

The EPA has provided benchmarks to aid in the assessment of potential risk associated with dispersant-related chemicals.[1]

Water and sediment samples associated with the DWH oil spill were analyzed to determine if any dispersant-related chemicals could be detected. Some of the chemical analyses used existing EPA methods that EPA modified to enhance the performance of the method for the particular chemical. Other chemicals required the creation of new methods that EPA also developed. Table A-1 summarizes the dispersant-related chemicals measured during the response, the associated analytical method, and the aquatic toxicity benchmarks for these chemicals in water. Currently, there are no benchmarks for dispersant-related chemicals in sediments.

Table A-1. Summary of EPA analytical methods and screening levels for dispersant chemicals in water samples

Compound	CAS Number	EPA Method ID	Technology	Reporting Limits	EPA Aquatic Life Benchmark
Propylene Glycol	57-55-6	EPA SW 846 Modified 8270	Direct Inject GC/MS	500 µg/L	500,000 µg/L
2-Butoxyethanol	111-76-2	EPA R5/6 LC	Direct Inject LC/MS/MS	125 µg/L	165 µg/L
Di(Propylene Glycol) Butyl Ether (DPNB)	29911-28-2	EPA R5/6 LC	Direct Inject LC/MS/MS	1 µg/L	1 mg/L (chronic)[2]
Dioctylsulfosuccinate, sodium salt (DOSS)	577-11-7	EPA RAM-DOSS	LC/MS/MS	20 µg/L	40 µg/L (chronic)

A.2 Human Health Benchmarks

The EPA, in coordination with the U.S. Department of Health and Human Services, developed benchmarks to assess potential human health risks from exposure to oil-contaminated water.[3] Human health benchmarks are based on potential cancer and non-cancer risks associated with exposure to oil-contaminated water in the Gulf (for a child swimmer assuming an exposure of 90 hours). These benchmarks are designed for comparison to water samples only. If a sample exceeds a benchmark value for any of the chemicals listed below, the sample is reported as exceeding the Human Health Benchmark.

Table A-2. Human Health Benchmark values by chemical

CHEMICAL	CAS Number	Human Health Benchmark	Toxicity

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[1] http://www.epa.gov/bpspill/dispersant-methods.html

[2] Chronic screening level for DPNB agreed upon by BP and EPA during the DWH response.

[3] http://www.epa.gov/bpspill/health-benchmarks.html

Volatile Organic Compounds, µg/L			
Benzene	71-43-2	380	C
Cumene	98-82-8	20,000	N
Ethylbenzene	100-41-4	610	C
Total xylene*	108-38-3	18,000	N
Toluene	108-88-3	120,000	N
Semivolatile Organic Compounds, µg/L			
2-Methylnaphthalene	91-57-6	170	N
Polyaromatic Hydrocarbons (PAHs) µg/L			
Naphthalene	91-20-3	1,800	N
Acenaphthene	83-32-9	2,500	N
Fluorene	86-73-7	12,000	N
Anthracene	120-12-7	22,000	N
Fluoranthene	206-44-0	UD	
Pyrene	129-00-0	4,100	N
Benzo(a)anthracene	56-55-3	UD	
Chrysene	218-01-9	UD	
Benzo(b)fluoranthene	205-99-2	UD	
Benzo(a)pyrene	50-32-8	UD	
Benzo(k)fluoranthene	207-08-9	UD	
Indeno(1,2,3-cd)pyrene	193-39-5	UD	
Dibenzo(a,h) anthracene	53-70-3	UD	
Metals, µg/L			
Nickel	7440-02-0	15,000	N
Vanadium	7440-62-2	5,400	N
*total xylene based on the most toxic of the xylenes (m-xylene)			
C - Concentration for generally acceptable cancer risk level			
N - Concentration for generally acceptable exposure for non-cancer endpoint			
UD - Benchmark under development			

A.3 Aquatic Life Benchmarks for PAHs

The EPA has provided benchmark values to aid in the assessment of potential risk to fish and other marine life that may come into contact with oil present in the water column or sediment. [1][2]

The effects of PAHs are additive across all of the PAH compounds in petroleum. For a single PAH, only a small percentage of the overall effect of the petroleum-contaminated mixture is measured. To determine the overall toxicity of PAHs in water or sediment, the contributions of every individual PAH compound in the petroleum mixture must be included (Table A-3). The effect of the mixture is calculated by adding together the fractional contributions of all components of the mixture. To estimate the total effect of the mixture of PAHs in an oil sample, the concentration of each compound is divided by a "potency divisor" before the ratios are added together (Table A-3). Potency divisors are not chemical-specific benchmarks, but are intermediates used in calculating the aggregate toxicity of the mixture. These potency divisors are used in the calculation to represent the amount of an individual chemical alone that could cause an adverse effect. After division by the acute or chronic potency divisor, the individual components are summed up – if the total is > 1, the sample exceeds the benchmark. Detailed sample calculations are available on the EPA website.[3]

Special consideration for sediment samples

To determine toxicity in sediment from PAHs, it is important to also factor in the amount of total organic carbon (TOC) in the sediment. When organic carbon is present in sediment, PAHs bind to it, making the PAHs less available to aquatic life, thus lessening their toxicity. In order to account for the differences in bioavailability, the dry weight-based PAH concentrations measured in sediment are divided by the TOC concentration.

Special consideration for samples in which alkyated PAHs were not measured

When evaluating a sample in which the alkylated PAHs were not measured, the EPA has devised a method to compensate for their contribution by using "alkylation multipliers". These multipliers account for the unmeasured alkyl compounds that are missed. The multipliers were created based on the reported analyses of a tar ball collected from Dauphin Island and forensically identified to be of MC252 origin. The multipliers were also checked against the published oil composition from the Exxon Valdez spill. These two samples were used by the EPA as they were available and represented two different crude oil types and weathering states. See Appendix C.3 for a discussion of the use of these multipliers within this report.

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[1] http://www.epa.gov/bpspill/water-benchmarks.html

[2] http://www.epa.gov/bpspill/sediment-benchmarks.html

[3] http://www.epa.gov/bpspill/water/explanation-of-pah-benchmark-calculations-20100622.pdf

Table A-3. Oil related organic compounds, analytical methods, and potency divisors (acute and chronic) used in the cumulative PAH Aquatic Toxicity Benchmark calculation.

PAH Compounds	CAS Number	Alkylation Multiplier	Acute Potency Divisor		Chronic Potency Divisor	
			Water (µg/L)	Sediment (µg/kg C)	Water (µg/L)	Sediment (µg/kg C)
Benzene	71-43-2	N/A	27,000	3,360,000	5,300	660,000
Cyclohexane	110-82-7	N/A	1,900	4,000,000	374	786,000
Ethylbenzene	100-41-4	N/A	4,020	4,930,000	790	970,000
Isopropylbenzene / Cumene	98-82-8	N/A	2,140	5,750,000	420	1,130,000
Total xylene	108-38-3	N/A	3,560	4,980,000	700	980,000
Methylcyclohexane	108-87-2	N/A	463	4,960,000	91	976,000
Toluene	108-88-3	N/A	8,140	4,120,000	1,600	810,000
Naphthalene	91-20-3	120	803	1,600,000	193	385,000
C1-Naphthalenes	--	N/A	340	1,850,000	81.7	444,000
C2-Naphthalenes	--	N/A	126	2,120,000	30.2	510,000
C3-Naphthalenes	--	N/A	46.1	2,420,000	11.1	581,000
C4-Naphthalenes	--	N/A	16.9	2,730,000	4.05	657,000
Acenaphthylene	208-96-8	1	1,280	1,880,000	307	452,000
Acenaphthene	83-32-9	1	232	2,040,000	55.8	491,000
Fluorene	86-73-7	14	164	2,240,000	39.3	538,000
C1-Fluorenes	--	N/A	58.1	2,540,000	14	611,000
C2-Fluorenes	--	N/A	22	2,850,000	5.3	686,000
C3-Fluorenes	--	N/A	7.99	3,200,000	1.92	769,000
Phenanthrene	85-01-8	6.8	79.7	2,480,000	19.1	596,000
Anthracene	120-12-7	1	86.1	2,470,000	20.7	594,000

PAH Compounds	CAS Number	Alkylation Multiplier	Acute Potency Divisor		Chronic Potency Divisor	
			Water (µg/L)	Sediment (µg/kg C)	Water (µg/L)	Sediment (µg/kg C)
C1-Phenanthrenes	--	N/A	31	2,790,000	7.44	670,000
C2-Phenanthrenes	--	N/A	13.3	3,100,000	3.2	746,000
C3-Phenanthrenes	--	N/A	5.24	3,450,000	1.26	829,000
C4-Phenanthrenes	--	N/A	2.33	3,790,000	0.559	912,000
Fluoranthene	206-44-0	1	29.6	2,940,000	7.11	707,000
Pyrene	129-00-0	2.1	42	2,900,000	10.1	697,000
C1-pyrene/ fluoranthenes	--	N/A	20.3	3,200,000	4.89	770,000
Benzo(a) anthracene	56-55-3	1	9.28	3,500,000	2.23	841,000
Chrysene	218-01-9	5	8.49	3,510,000	2.04	844,000
C1-Chrysenes	--	N/A	3.56	3,870,000	0.856	929,000
C2-Chrysenes	--	N/A	2.01	4,200,000	0.483	1,010,000
C3-Chrysenes	--	N/A	0.699	4,620,000	0.168	1,110,000
C4-Chrysenes	--	N/A	0.294	5,030,000	0.0706	1,210,000
Perylene	198-55-0	1	3.75	4,020,000	0.901	967,000
Benzo(b) fluoranthene	205-99-2	1	2.82	4,070,000	0.677	979,000
Benzo(k) fluoranthene	207-08-9	1	2.67	4,080,000	0.642	981,000
Benzo(e)pyrene	192-97-2	N/A	3.75	4,020,000	0.901	967,000
Benzo(a)pyrene	50-32-8	1	3.98	4,020,000	0.957	965,000
Indeno(1,2,3-cd)pyrene	193-39-5	1	1.14	4,620,000	0.275	1,110,000
Dibenz(a,h) anthracene	53-70-3	1	1.17	4,660,000	0.282	1,120,000
Benzo(g,h,i) perylene	191-24-2	1	1.83	4,540,000	0.439	1,090,000

Appendix B: Data Management

B.1 Scribe

Early in the response, a decision was made to use Scribe as the official database for managing unifying, and distributing analytical sample data. Scribe is a database developed by the USEPA's Environmental Response Team to assist in the process of managing environmental data. Scribe is also managed by the EPA.

Data in Scribe includes all sub-surface water column and sediment samples collected as part of the response for laboratory analysis (i.e. data originating from a number of agencies including Federal and State agencies, as well as BP-contractors).

Scribe captures sampling, observational, and monitoring field data. Examples of Scribe field tasks include soil sampling, water sampling, air sampling and biota sampling. Scribe can import electronic data, including analytical lab result data and sampling location data, such as GPS.

Scribe outputs include labels for collected samples, chain of custody generation, and analytical lab result data reports. Scribe provides a flexible user interface to manage, query, and view all this information. Scribe supports exporting electronic data for user services, such as GIS tools and spreadsheets, so sampling data may be further analyzed and incorporated into report writing and deliverables.

The main Scribe server (Scribe.NET) provides a method of storing and sharing Scribe projects. Using Scribe.NET, Scribe projects can be shared between Scribe desktop clients and/or enterprise Oracle/SQL database clients. Scribe projects are “Published” from the Scribe desktop client, and other desktop/enterprise users “Subscribe” to the published projects. Users can subscribe to individual or multiple projects. Regional or global subscriptions can also be created for sharing entire sets of published projects. Some Scribe functions and limitations are listed:

- Data may be loaded manually or in an electronic file.
- There is no error checking utility to verify that the electronic data have been loaded successfully.
- Sample location coordinates output from a global positioning system (GPS) may be entered electronically.
- Without expert knowledge, it is still possible for the user to complete a sampling event by following logical steps.
- Some knowledge of database functions is required to filter data results and set up views.

B.2 NODC

The NOAA National Oceanographic Data Center (NODC) served as the official database and archive for oceanographic data collected aboard vessels. Examples of products that OSAT used from NODC included CTD, fluorescence, and dissolved oxygen profiles. The initial repository for oceanographic data from vessels was the NOAA Office of Response & Restoration (OR&R) secure file transfer protocol (SFTP) server. OSAT used a variety of products from this site including, for example, daily ship deliverables with qualitative descriptions of sediment samples. The NOAA OR&R Environmental Response Management Application (ERMA) served as the primary visual tool within the UAC. These data are available in ERMA's map and display format. Oil presence or absence observational data are also available in map and display format in ERMA.

B.3 Quality Control, Quality Assurance and Validation

The purpose of data validation was to detect and to correct errors and then to verify that all data values correctly represent the actual conditions at the sampling station. Effective data validation procedures were usually completely independent of the procedures of the initial data collection. Moreover, it was advisable that the individuals responsible for data validation not be directly involved with data collection. Data validation was necessary to identify data with errors, biases, and physically unrealistic values before they were used for identification of exceedances, for analysis, or for modeling. Data validators were charged to validate data generated by the laboratories for chemical analyses of project samples. Data generated for toxicological assessments were reviewed by appropriate science advisors.

In addition to the laboratory quality assurance (QA) review, data sets were evaluated and validated by experienced personnel for the following criteria:

- Conformance with requested testing requirements,
- Completeness,
- Reporting accuracy (including hardcopy of Electronic Data Deliverables),
- Confirming receipt of requested items, and
- Traceability, sensibility, and usability of the data.

In addition to the above criteria, the data validators used guidance from two EPA publications where appropriate and applicable:

- *US EPA Contract Laboratory Program National Functional Guidelines for Superfund Organic Methods Data Review, EPA-540-R-08-01* (June 2008)
- *National Functional Guidelines for Inorganic Data Review* (October 2004).

It should be noted that these guidelines were not completely applicable to the EPA and SW-846 methods used in the response. Consequently, professional judgment was used to evaluate data usability.

Data acquired by subsurface monitoring and sampling efforts were considered validated upon completion of quality assurance (QA) and quality control (QC) procedures. The originating entities that prepared the sampling plans for the data and results, but not those individuals involved in taking the samples, were responsible for QA, QC, and validation. QA/QC procedures begin at the time of data capture (such as sampling procedures shipboard), in laboratory settings, and before data are delivered to Scribe or NODC. The EPA's QA levels and their definitions are listed below:

Level 1: A verification and validation based only on completeness and compliance of sample receipt condition checks.

Level 2: A verification and validation based on completeness and compliance checks of sample receipt conditions and both sample-related and instrument-related QC results.

Level 3: A verification and validation based on completeness and compliance checks of sample receipt conditions, both sample-related and instrument-related QC results, and recalculation checks.

Level 4: A verification and validation based on completeness and compliance checks of sample receipt conditions, both sample- and instrument-related QC results, recalculation checks, and the review of actual instrument outputs.

One exception to the validation described above is the data analyzed from the early stages of the response at the Louisiana State University (LSU) laboratory in Baton Rouge. These data were not validated to Level 2 because some sample documentation lacked information pertaining to chain of custody or laboratory standard operating procedures for preparation and analyses of samples. These data also had higher than normal method-detection limits than the data sets from commercial laboratories with rigid standard procedures.

B.4 Qualifications on the Data—Lab Qualifiers

The following definitions provide brief explanations of the qualifiers assigned to results in the Scribe database for the Deepwater Horizon response.

B The analyte is found in the associated blank, as well as in the sample. It indicates possible/probable blank contamination and warns the data user to take appropriate action. This flag is used to positively identify a target compound list (TCL) compound. A tentatively identified compound (TIC) found in both the sample and the associated blank receives an “R” flag.

C The sample results are confirmed by other analytical techniques, including analysis of a reference standard.

D This flag identifies all compounds in an analysis at the secondary dilution factor. If a sample or extract is reanalyzed at a higher dilution factor, as in the “E” flag, the “DL” suffix is appended to the sample, and all concentration values reported on Form 1 are flagged with the “D” flag.

E This flag identifies compounds whose concentrations exceed the calibration range of the gas chromatograph/mass spectrometry (GC/MS) instrument for that specific analysis.

J The analyte was positively identified, but the associated numerical value is an estimated concentration of the analyte in the sample based on its associated quality measures.

JN A combination of the “J” and “N” qualifiers, this analysis indicates that the analyte is “tentatively identified” and the associated numerical value may not be consistent with the amount actually present in the environmental sample.

N The analysis indicates the presence of an analyte for which presumptive evidence creates a “tentative identification.”

R The sample results are rejected due to serious deficiencies in the ability to analyze a sample and meet QC criteria. The presence or absence of the analyte cannot be verified.

U The analyte was analyzed for but not detected above the method detection limit, as defined in the laboratories’ Statements of Work.

U* This analyte is considered “not detected” because it was detected in an associated blank at a similar level.

UJ The analyte was analyzed for but not present above the level of the associated value. The associated numerical value may not accurately or precisely represent the concentration necessary to detect the analyte in this sample.

UR Unusable detection limit; analyte may or may not be present in this sample

X The datum is tentatively rejected because project-specific data quality objectives (e.g., for sensitivity, accuracy, or precision) were not met or were not demonstrated. When objectives for sensitivity are not met, the X flag typically indicates that a result (a detection or non-detection) is potentially unusable with respect to an action level (e.g., the result does not demonstrate that a target analyte is actually present in an environmental sample at a concentration above or below a risk-based decision limit).

B.5 Data Flow

During the early period of the response and for most of the response time frame, data flow was controlled by the two primary Incident Command Posts (ICPs) in Houma, LA, and in Mobile, AL. At the ICP level, sampling plans were devised, field procedures defined, analyses outlined, and laboratories selected as needed. Various organizations ran projects for the ICPs and input data to Scribe. Primary projects are listed in Table B-1.

Data tended to flow as follows:

- After collecting individual samples onboard vessels or collecting individual samples in the field onshore, samples were transferred to the Sample Receiving Office (SRO) in Houma or in Mobile. Samples received at the SRO were unpacked, subjected to several QC checks and repacked for shipment to the appropriate laboratory (or laboratories) for analysis.
- After analysis, reports were issued to parties identified on the Analytical Request Form or as otherwise communicated to the laboratory and electronic data, and deliverables were sent to the designated entity. For BP the data were sent to

Environmental Standards, Inc. for uploading into the EQuIS[1] database or to CTEH, LLC (Center for Toxicology and Environmental Health). Data for other entities was sent to the appropriate agency (Federal or State) for uploading in to their in-house databases.

- The data originator was charged with performing a Level 2 data validation, and the data was subsequently published to Scribe (Table B-1).

Table B-1. Entities that published data to Scribe.

PROJECT NAME	ORGANIZATION
R06 Deep H2O Horizon Reporting	General Dynamics
DW_Operations	USEPA/ERT
DW_Reporting	USEPA/ERT
CTEH_DW_Sampling_Analytical	CTEH
BP_DW_Sampling_Analytical	Weston Solutions
LDEQ_DW_Sampling_Analytical	Weston Solutions
EnvStds_DW_Sampling_Analytical	Environmental Standards
ADEM_DW_Sampling_Analytical_Monitoring	Alabama DEM
CTEH_DW_Monitoring	CTEH
TS_DW_Monitoring	CTEH
MSDEQ_DW_Sampling_Analytical	MDEQ
FLDEP_DW_Sampling_Analytical	Florida DEP
NPS_DW_Sampling_Analytical	ERT
ALECI_DW_Sampling_Analytical	EnviroChem
Envstd_Sampling_Analytical	Environmental Standards
NOAADW	Weston Solutions
USGSDW	Weston Solutions

The Unified Area Command (UAC) located in Robert, Louisiana, and later in New Orleans, was advisory to the ICPs. Sampling plans were developed by various partners within the UAC and ICPs to address a diverse spectrum of objectives. Continuous improvement in procedures occurred as sampling plans, data management procedures, and QA plans were cross-referenced and standardized as much as possible as the response progressed.

Soon after the NIC directive of 3 August, the UAC began directing sampling of water and sediments beyond the shoreline. The Implementation Plan (13 September) and Operational Annex (1 October) assessed the existing and completed subsurface sampling and developed a framework to address identified sampling gaps. Data flow from existing

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[1] A commercial data management system

programs tended to follow the existing structures. New data flow followed GC-IMT procedures. All analytical data collected under this plan is or will be published to Scribe.

B.6 Long-Term Data Availability and Access

Long term data management, archive, and public dissemination of all analytical and oceanographic data collected in association with this response will be provided by the National Oceanographic Data Center (NODC) and the National Geophysical Data Center (NGDC).

Oceanographic data records are currently publicly available at the NODC DWH web site[1], as well as the NODC THREDDS Server[2] and the NCDDC EcoWatch THREDDS Server[3]. Geospatially-enabled direct data access is also available on the DWH Atlas[4]. As the data cleanup is completed within the Scribe database, the analytical chemistry data will also become publicly available.

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[1] http://www.nodc.noaa.gov/General/DeepwaterHorizon/support.html

[2] http://data.nodc.noaa.gov/thredds/catalog/DeepwaterHorizon/catalog.html

[3] http://ecowatch.ncddc.noaa.gov/thredds/catalog_dwh.html

[4] http://www.ncddc.noaa.gov/website/google_maps/DWHAtlas/mapsAtlas.htm

Appendix C: Issues Encountered, Resolutions and Compromises

C.1 Issues Encountered with Response Dataset in Scribe

Through the course of the response, approximately 17 entities published data to Scribe. Many of these entities also used a number of different laboratories for sample analysis. Laboratory standard operating procedures, analysis methods, and data formats varied, particularly early in the response. In addition, different naming conventions and relational data structures utilized by the different data originators resulted in numerous issues in the actual transfer of data to Scribe. For example, although metadata (e.g. sample latitude, longitude, depth) existed, it was often unsuccessfully transferred resulting in missing metadata within Scribe.

A significant issue that was not resolved at the time of this report had to do with non-unique sample names for different analyses conducted on the same sample. For example, in many cases, analyses for VOCs were run at a different lab than analyses for PAHs. Because the sample names were different (and not in one systematic way) the queries used to access the data in Scribe were not always able to match up all the analyses required for comparison to the aquatic life benchmark for PAHs. This also applied to sediment samples in which different analyses were run on the different cores originating from one cast (e.g. total organic carbon from one core barrel, PAHs from another). In this case, these were somewhat unique samples, as they originated from different cores within one cast, however, the benchmark calculation required them to be utilized together. Although the data managers have attempted to address this through the use of "linked" sample numbers, this has not been successfully resolved within a Scribe query to date. Therefore, as noted in the report body, multiple samples included in this report excluded VOC analyses in the benchmark calculation and/or used a default value for TOC even though it was measured.

Inconsistent naming conventions for the various analytes in data published to Scribe resulted in numerous difficulties with utilizing the entire available database. These inconsistent naming conventions resulted both in potential missing analytes (i.e. analyte name used by data originator was not included in search query), or double counting of analytes (i.e. data originator revised the analyte name but the data was inadvertently published twice). This posed a significant challenge to establishing confidence in the PAH aquatic toxicity ratios in particular, as they required the addition of results from numerous analytes. Many of these inconsistencies were ultimately resolved, but preliminary maps and analyses had errors and were continually revised as the underlying dataset in Scribe was revised. This issue was ameliorated in more recent sample analyses when input was standardized, including analyte naming conventions, concentration units, and inclusion of metadata such as location, depth, matrix, etc.

The datasets pulled from Scribe by the OSAT were also inconsistent — data available one day was not retrieved consistently on subsequent queries. Note, the raw data itself was unchanged, but the number of samples retrieved by the query was not consistent. Explanations of this inconsistency include the instability in the underlying data structure as data originators refreshed their datasets to Scribe, changes in query methods used by rotating data support personnel, or QA/QC activities of which the OSAT was unaware. OSAT continued to work this issue through the final data retrievals.

On a few occasions, Scribe was unable to handle the volume of data being uploaded (these occurred after data originators performed substantial revisions and re-uploaded large datasets). The solution was to limit the upload to 75,000 records at a time – however, this meant that refreshing the data took almost 12 hours to complete.

In addressing all of the issues encountered with utilizing the Scribe database, corrections were cumbersome and time consuming, and required multiple republishing of data from the various sources. It took an inordinate number of attempts and a great deal of time to get consistent, reliable downloads of datasets from Scribe after all of the data had been published. Only very technically skilled individuals could accomplish this operation, thus limiting the utility of the database.

Most of these inconsistencies are the result of multiple source providers operating under emergency response conditions, and it should also be noted that the bulk of the data records were, in fact, effectively handled and accessed. However these data issues are being addressed to ensure that future exposure and analyses can be executed more efficiently. Specifically, all relevant data records are undergoing a thorough verification screening at NOAA's National Oceanographic Data Center (NODC), and a coincident validation process is also ongoing. In addition, complete metadata records are being verified for all records. Data will be transitioned from SCRIBE, which was designed for rapid emergency response data needs, to a more robust and accommodating database structure (SQL) for long-term stewardship and exposure. Finally, data will be exposed in ERMA, Geoplatform.gov and other publicly accessible access points to ensure more effective and broad distribution.

C.2 Excluding Data Inappropriate for OSAT Review

During the response, many sampling programs were designed for diverse objectives. Although suitable for their intended purpose, not all of the analytical data input to Scribe for the response were appropriate for use in OSAT reviews of the three defined areas. For example, Rapid Assessment Team (RAT), Forensic Rapid Assessment Team (FRAT), Coast Guard Special Monitoring of Applied Response Technologies (SMART), anomalous phenomena, waste samples, and others were not designed for evaluation of the environmental conditions. For example, RAT and FRAT data were actual samples of oil and not of water or of tarballs. Well over 40,000 samples were analyzed for the response; of those samples, approximately 17,000 (less than 50%) were appropriate for OSAT review

As data from many of these programs was also published to Scribe, it was necessary to exclude these samples from consideration. Unfortunately, as they did not always have a unique identifier, this was more difficult in practice than in concept. Inclusion of these samples overestimated exceedances of toxicity benchmarks, as they were in many cases, actual oil samples.

C.3 Alkylated PAHs

The EPA aquatic toxicity ratios (Appendix A.3) are meant to be calculated using the 41 oil-related organic compounds (i.e., including benzene, toluene, ethylbenzene and xylene or BTEX for short, priority pollutant polycyclic aromatic hydrocarbons (PAHs), and the alkylated PAH compounds). However, many samples (particularly in the nearshore sampling zone) were analyzed only for the 16 priority PAHs that are the norm for the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA, or Superfund) style evaluations. The EPA determined that when evaluating a sample in which the alkylated PAHs were not measured, it is necessary to compensate for their contribution by using "alkylation multipliers": these multipliers are meant to account for the unmeasured alkyl compounds (see Appendix A.3 for more detail on the development of these multipliers).

EPA's 16 priority PAHs should NOT be the only targeted oil related organic compounds to be measured and monitored during an oil spill. Crude oil generally consists of only 1-2% parent PAH compounds and alkylated homologs: of this fraction, crude oil contains mostly the alkylated PAHs, hence concentrations of these compounds needs to be assessed. Although multipliers have been developed to account for their contributions based on measured concentrations of the parent compounds (Appendix A.3), the parent PAH concentrations in crude oil may be close to the detection limits and hence reported as 0, potentially resulting in the multipliers being ineffective. OSAT recognized this issue soon after they began reviewing the dataset and made a recommendation that all future samples be analyzed for the complete set of analytes (20 September, Appendix F). However, a substantial number of earlier samples in the nearshore zone (and a much smaller subset in the other zones) included only the 16 priority PAHs.

As it was necessary to use the multipliers for many nearshore samples collected pre-20 September, OSAT attempted to assess the efficacy of drawing conclusions using toxicity ratios calculated from samples in which only the 16 priority pollutants were measured. A statistical comparison was performed. For all samples with the full suite of 41 analytes, toxicity ratios were calculated twice: once using all 41 analytes and a second time using only the 16 priority PAHs (with the multipliers). Toxicity ratios calculated using priority PAHs alone were positively correlated (though statistically not significant, P-value >0.05) with those from the 41 analytes using Pearson correlation coefficient. High variability in toxicity ratios precluded estimating an accurate and precise relationship between the two. This high variability likely resulted from the broad range in concentrations and weathering states.

Although this analysis indicated some limitations in the applicability of using these multipliers, the OSAT decided it was more conservative to include these data (with appropriate caveats) for assessing potential exceedances of the aquatic life benchmark. Therefore, we include in this report toxicity ratios calculated using both the 16 priority PAHs alone and using all 41 analytes. Fortunately, the most recent samples (post the 20 September OSAT recommendation) were analyzed for the full suite of analytes[1] – these samples are the most essential for determining post-impact environmental conditions.

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[1] With the exception of EPA Region 6 samples which are currently being reanalyzed.

C.4 Total organic carbon

Total organic carbon (TOC) is necessary to calculate the aquatic life ratio for sediments (Appendix A.3). Because organic chemicals tend to adhere to organic matter in sediment, the higher the TOC is in sediments, the lower will be the hazard to organisms from toxic organic compounds.

TOC analysis was not always performed on sediment samples early in the response. In addition, in multi core sampling, the TOC was analyzed from a separate barrel from the PAHs and the samples were not able to be linked within the Scribe queries (Appendix C.1). In cases where TOC was not available, OSAT used an assumed TOC of 1% in the calculations. Using this TOC value provided a modestly conservative estimate of the risk hazard (the mean TOC detected in samples was 1.22%). However, as TOC generally decreases in the deep water, this may not be a conservative estimate for all deep-water sample sites. An independent calculation of the aquatic life ratio in offshore and deep-water samples which utilized the measured TOC was performed outside of the Scribe query. Results of this analysis indicated one additional exceedance in deep-water sediments within 3 km of the wellhead.

C.5 Volatile organic compounds

Volatile organic compounds (VOCs) such as BTEX, are required for calculating the aquatic toxicity ratios. Although the analysis for these compounds was standard in samples from the deep-water and offshore zones, some nearshore samples did not include these compounds in their analysis. In addition to this, in many recent water and sediment samples from the offshore and deep-water sampling zones, non-unique or non-linked sample names for different analyses precluded matching up VOC analyses with PAH analyses (Appendix C.1/C.7).

However, in samples that were analyzed for BTEX, these compounds were never detected in MC252 oil that reached the shore, nor were BTEX compounds detected in nearshore sediments. Analyses of oil samples from the source toward the shore showed that VOCs were either dissolved or evaporated from the MC252 oil near the source, and oil that approached the nearshore environment no longer had BTEX compounds present (Gong et al., 2010, Brown et al., 2010).

C.6 Method detection limits

Different data sets had different method detection limits (MDLs) for specific analytes, which complicated the comparison of data and calculations of aquatic life benchmark indices across the response. In some cases, such as at CERCLA sites, the EPA recommends using half (0.5) the MDL in calculating environmental benchmarks. Some analyses from the response had such high MDLs, however, that this technique for calculation resulted in exceedances where no analytes were actually detected. The EPA example method of calculating benchmarks for this incident used a zero value for results below the method detection limits. Therefore, only analytes that were "detected" at or above the MDLs were used for calculation purposes. This process is in conformance with the example calculation method provided by the EPA on their website[1]. Data with concentrations below the MDL were labeled "U" for non-detect in the qualification column in Scribe.

C.7 Multi Core Sediment Samples from Multiple Barrels

During some sediment sampling activities both offshore and in deep water, multi core devices were used that took several sediment core samples with a single device in one cast. In some cases, samples for volatile organic compounds (VOCs) were taken from one core in the array, and samples for semi-volatile organic compounds (SVOCs) were taken from another. Because the samples for VOC analyses were from different core barrels, they were given names slightly different from the samples for SVOC analysis. Calculating aquatic life toxicity ratios combines both analyses. Unfortunately, the naming conventions utilized precluded matching up the samples within the Scribe queries (Appendix C.1).

C.8 Exceedances Resulting From LSU samples

As noted in the section on QC, QA, and data validation, a number of analyses from LSU could not be validated because some documentation lacked chain of custody or laboratory standard operating procedures for preparing and analyzing samples. These samples also displayed some of the highest aquatic toxicity ratios. From audit interviews, it appears that these samples were screened after extraction and that only the samples with the greatest indication of contamination were analyzed. Additionally, some samples of oily water that included free-phase petroleum were included in the "water" analyses. Nevertheless, these were key samples in the early stages of deep water monitoring and were included in the OSAT review.

C.9 J data

Data labeled J in the qualification column were used in benchmark calculations. A J value indicated that an analyte was positively identified, but the associated concentration was estimated because the confidence in the quantitation of that analysis was below the laboratory's quality performance measure. Although in many environmental reviews J data is excluded from regulatory consideration, these data were kept in the OSAT review to err on the conservative (high) side of considering analyte concentrations..

C.10 Tentatively identified compounds

The TICs (labeled **N** in the qualification column) were not used in benchmark calculations.

C.11 DEEP

The Dispersant Environmental Effects Project (DEEP) monitored dispersant effectiveness during the response. This study involved sampling water beneath observed surface oil (at 1 m and 10 m depth) both before and after dispersant application (as well as some additional background sampling in areas without visible surface slicks). Sampling was conducted across all three zones, in the months of May, June and July 2010. Although this study was not intended for assessing distribution of oil or dispersant products in the subsurface

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[1] http://www.epa.gov/bpspill/water/explanation-of-pah-benchmark-calculations-20100622.pdf

environment, as it directly targeted known impacted areas, it is included in the dataset reviewed by the OSAT.

Appendix D: Characterization of Source in Exceedance Samples

This section describes the data evaluation process used by OSAT to determine the source of analytes present in water and sediment samples that exceeded the chronic aquatic life benchmark. In general, the focus was on determining whether exceedance samples were "consistent" or "not consistent" with MC252 oil, with some samples remaining of indeterminate origin when not enough data was available. Samples whose source was indeterminant were considered as consistent with MC252 in all plots and tabulations of exceedances within this report. Depending on the analytes available for a sample, different methods were used for source determination. The following describes source determination for BTEX-only samples, samples containing only priority pollutant PAHs, and full-alkyl PAH samples.

D.1 BTEX-Only Samples

If BTEX analytes were the only compounds detected for a sample[1] with an aquatic life exceedance, then the BTEX compounds present were considered to be from a petrogenic (MC252) source. This was a conservative approach that assumed the presence of BTEX in water samples was indicative of a water soluble fraction or water accommodated fraction (WAF) from petroleum. Since a source determination cannot be based on BTEX data alone, the source was considered to be MC252. Nearly all samples in this category were from the deep water areas, and likely associated with the deepwater fluorescence (~1100-1300 m) documented by the oceanographic surveys.

D.2 Types of PAH Samples

Two types of PAH sample data were available for the water and sediment samples, priority pollutant (PP) PAH and full alkyl PAH. The evaluation process to determine the presence of MC252-based hydrocarbons for samples with aquatic life exceedances differed based on whether PP PAH or alkyl PAH data were available. A description of the procedure for each of the two data types is described below.

D.3 Priority Pollutant PAH Samples

The first step was to evaluate the distribution of PAHs in the sample using a bar graph of the analyte concentrations. This was done to determine if: a) a possible petrogenic (petroleum related) signature was present, or b) a possible pyrogenic (combustion related) signature was present. For water samples, the evaluation included a possible water accommodated fraction distribution.

A petrogenic PAH distribution was interpreted if the PAH analytes present were consistent with fresh or weathered petroleum. This included the presence of naphthalene, fluorene, and phenanthrene, with lower levels of chrysene. A possible petrogenic WAF was interpreted if naphthalene, fluorene and phenanthrene were present, with a general pattern of naphthalene higher in abundance than fluorene which is higher than phenanthrene. A PP PAH petrogenic

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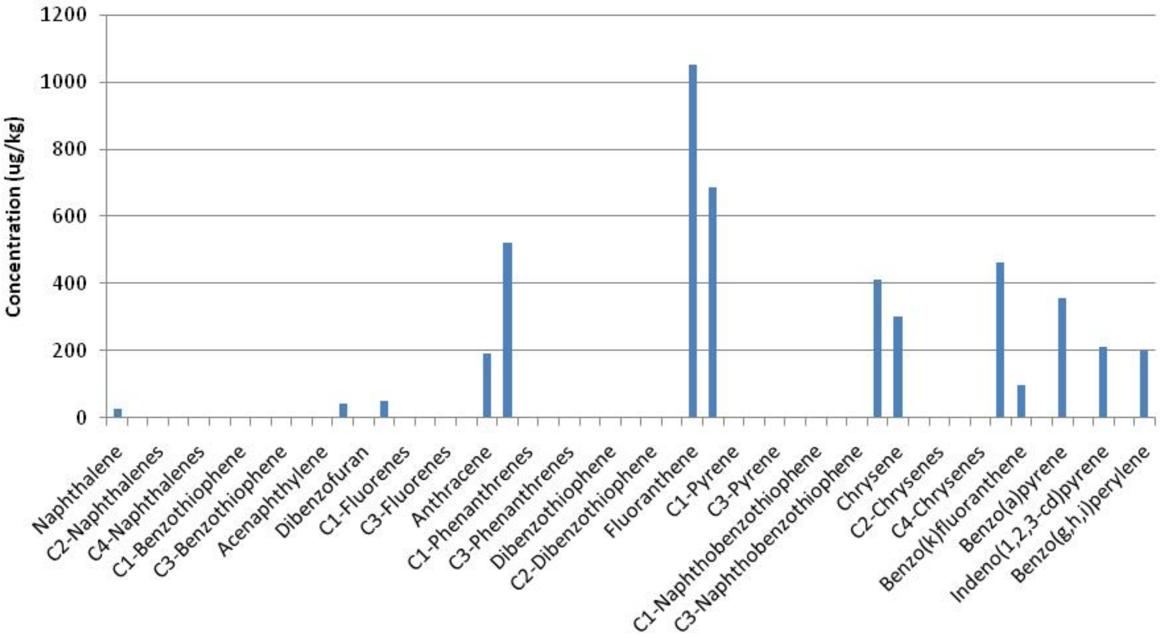
[1] Detectable concentrations of BTEX were found almost exclusively in water samples and only rarely in any sediments.

distribution was categorized as “consistent with MC252 oil”, since determining the source is not definitive based on the PP PAH data alone. If only one or two petrogenic PAH analytes were detected (e.g., naphthalene alone, which is a common lab contaminant), then the sample was categorized as “indeterminate” source, as not enough information is present to make a source determination.

A pyrogenic PAH distribution was interpreted if the common pyrogenic PAHs were the primary components in the PP PAH distribution. The PP PAHs characteristic of a pyrogenic source include: fluoranthene, pyrene, benz(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, benz(e)pyrene, benz(a)pyrene, indeno(1,2,3-c,d)pyrene, dibenz(a,h)anthracene and benz(g,h,i,)perylene. As is common with pyrogenic PAH distributions, fluoranthene and pyrene were often the most abundant analytes in the overall distribution. Samples identified as pyrogenic PAH were classified as being from “not consistent with MC252 oil”. An example histogram of PAHs from a pyrogenic sediment sample is shown in Fig. D-1.

Fig. D-1. Histogram of PAHs from a pyrogenic sediment sample. The sample ID is T007-1331-100807-SD-1 collected on 7 August.



In some cases additional hydrocarbon data, such as total petroleum hydrocarbon (TPH), gas range organics (GRO), diesel range organics (DRO), and oil range organics (ORO), were available in addition to the PP PAH. If available, the other hydrocarbon data was evaluated and used to confirm the presence of crude oil in the samples. For example, in one case the absence of crude ORO, but the presence of DRO hydrocarbons was used to categorize a sample with a petrogenic PP PAH designation as “not MC252 oil” since diesel was the primary hydrocarbon constituent.

D.4 Full-Alkyl PAH Samples

The initial evaluation of the alkyl PAH data followed a similar procedure, with the generation of PAH distribution plots for all of the target analytes. The samples were evaluated using the same process to interpret whether PAH distribution were petrogenic or pyrogenic. A pyrogenic PAH signature was determined using the same analyte and distribution criteria as described above for the PP PAH. Petrogenic PAH distributions were identified by the presence of a suite of alkyl PAHs. The characteristic petrogenic alkyl PAH distribution generally included alkyl naphthalenes, phenanthrenes and chrysenes, where the C-2 or C-3 alkyl groups were the most abundant in the distribution. Samples with aquatic life exceedances that had a petrogenic alkyl PAH distribution were categorized as “MC252 oil” if there was no other data available for review.

However, most samples with alkyl PAH data had additional hydrocarbon data including alkane and biomarker (steranes and triterpanes) concentrations, gas chromatography/mass spectrometry (GC/MS) biomarker extracted ion chromatogram profiles (extracted ion current profiles [EICPs]) and gas chromatography/flame ionization detection (GC/FID) chromatograms. In all cases for which additional data were available, the presence of MC252 oil was confirmed by comparisons of the biomarker and alkane distributions in the samples to those of the Q4000 (MC252) control oils analyzed along with each batch samples. A histogram of the PAHs in the Q4000 control oil is shown in Fig. D-2. An example histogram is also shown for PAHs consistent with MC252 oil found in a sediment sample near the wellhead (Fig. D-3). If the biomarker and alkane comparisons were not consistent with the MC252 oil, then the sample exceedance was categorized as “not MC252 oil”.

Fig. D-2. Histogram of PAHs in the Q4000 MC252 control oil.

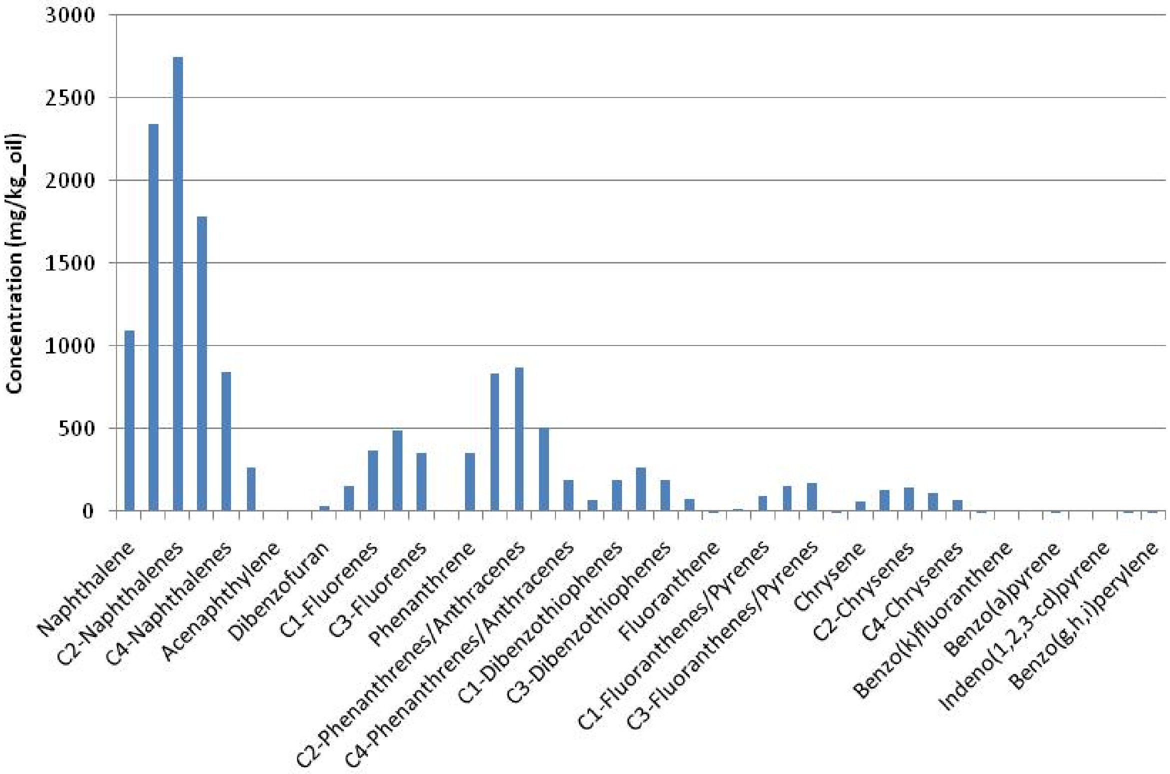
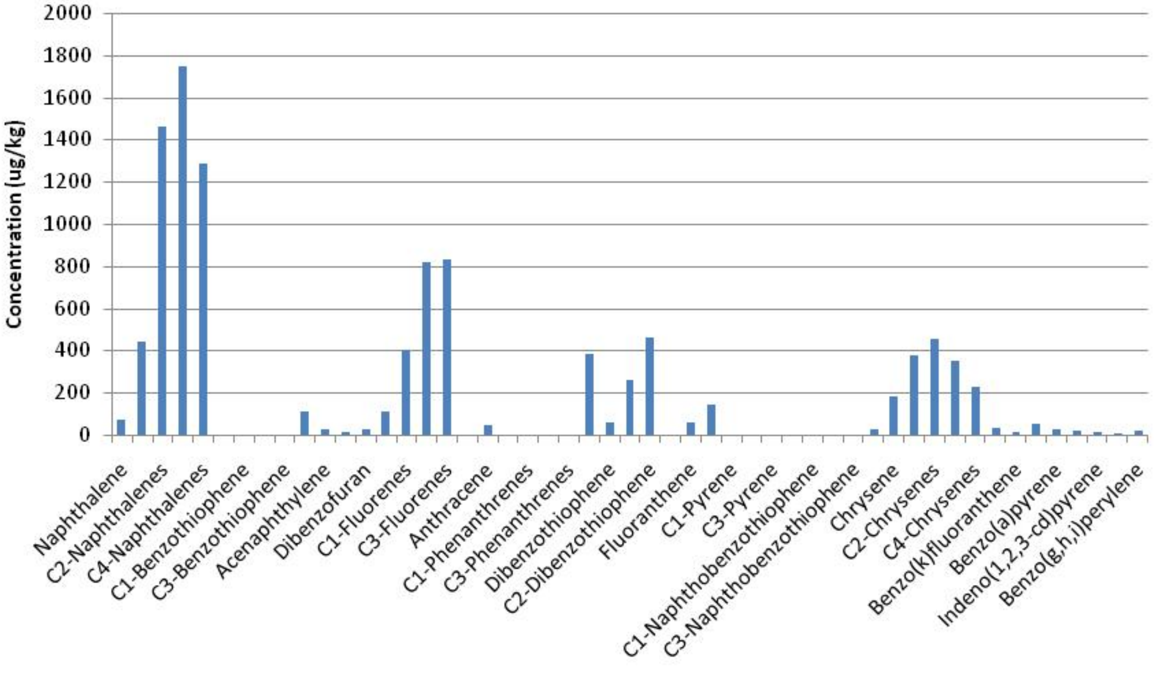


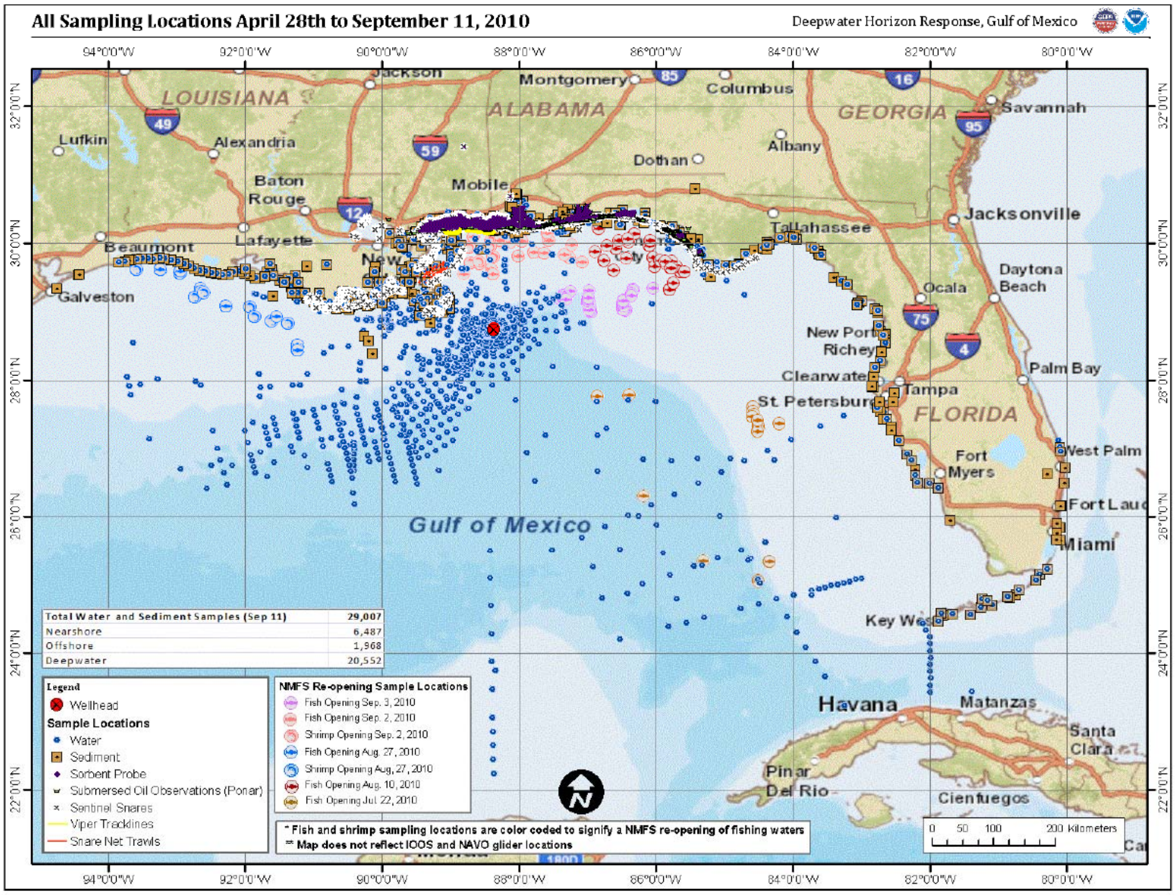
Fig. D-3. Histogram of PAHs in a sediment sample that was consistent with MC252 oil within 3 km of the wellhead. The sample ID was SE-20101017-GY-D038SW-HC-053_BDO collected on 17 October by the R/V Gyre.



Appendix E: Sampling Programs Addressed in the OSAT Summary Report

An overwhelming number of scientific observations and samples have been collected since the beginning of the response. There were also simultaneous sampling efforts being conducted as part of the NRDA process. Prior to the systematic sampling plan laid out in the Implementation Plan (13 September) and refined in the Operational Annex (1 October), the majority of these samples were collected under specific programs designed and managed independently by the Houma and Mobile Incident Command Posts (ICPs) for a diverse set of objectives (see Figure E.1 for locations of samples taken between 28 April and 11 September). Building on previous and existing sampling programs, the Implementation Plan and the Operational Annex proposed a statistically based adaptive approach for enhanced sampling.

Figure E.1. Sample locations from 28 April 2010 to 11 September 11 2010. (*From* Implementation Plan, 13 September 2010.)



The following sections describe some of these independent sampling programs undertaken by the Houma and Mobile ICPs (Sections E.1/E.2), and provide additional details about the sampling rationale developed in the Implementation Plan and the Operational Annex (Section E.4). This is not meant to be a comprehensive list, but details programs that created data which were utilized by the OSAT in preparing this report.

E.1 Mobile sampling programs in existence before the Implementation Plan

Nearshore water and sediment sampling program

The purpose of this sampling and analysis plan was to guide nearshore water sampling within approximately 3 nautical miles (nmi) from the coastline through Mississippi and Alabama state waters and within approximately 9 nmi from the coastline through the represented portion of Florida's state waters to evaluate water quality. Sampling sites were located near ecologically sensitive areas with a spatial separation of at least 5 miles to achieve even representation across the impacted areas. Samples were taken by CTEH at regular intervals, ranging from every other day early in the Response to monthly in October. Sampling areas were expanded or reduced, as needed, based on the results of consecutive sampling events or the identification of other sources. Water samples were analyzed for VOCs (EPA 8260), SVOCs (EPA 8279), DRO/ORO, propylene glycol and 2-butoxy ethanol (EPA 8015B), GRO (EPA 8015), and Target Analyte List Metals plus mercury

Sediment samples were collected from areas suggested by specific state agencies and were collected at the same frequency as the above water samples. Sediment samples were analyzed for VOC, SVOC, GRO/DRO/ORO, Metals (TAL), plus mercury, propylene glycol, and 2-butoxy ethanol.

Subsurface Oil Assessment Project

The Mobile area operations conducted an extensive program for sub-surface oil assessment to identify the presence of submerged and sunken oil in sub-tidal and nearshore areas. Samples were taken from Vessels of Opportunity by various contract personnel from the ICP. This program included five separate projects from Mississippi to NW Florida including: the Mississippi Sound Subsurface Assessment Project, the Coastal Subsurface Assessment Project, the Snare Sentinel Monitoring Project, the Vessels with Intrinsic Petroleum Ensnaring and Recovery Systems (VIPER) project, and the Snorkel SCAT Project (Mobile Oil Survey Summary 11-14-10).

USEPA Region 4

The EPA conducted a survey program to collect water and sediment samples from locations along the Mississippi, Alabama, and NW Florida coastlines. Samples were taken by EPA contractors. Samples were collected from National Coastline Condition Assessment (NCCA) locations and additional sites where oil was observed. A wide range of analyses were conducted, including oil chemistry analyses, dispersant tests and toxicity tests. Pre-impact data is available and monitoring is continuing. The NCCA program is continuous and was in existence before the DWH incident.

E.2 Houma sampling programs in existence before the Implementation Plan

Fate of Oil Research Team

The Fate of Oil Research Team (FORT) program was developed to collect water column and sediment samples (top 2 cm) in coastal offshore (<200 ft) water and nearshore areas along the Louisiana and Texas coast. Samples were collected for chemical analysis and toxicity studies. The M/V *International Peace* (which was previously used for dispersant studies) was used for the deeper areas and Vessels of Opportunity were used for the shallower water. Locations for sampling were identified using information from FRAT, RAT[1] and Snare data and areas where subsurface oil had been reported. Analyses from the FORT program were used in the OSAT dataset.

Snare Sentinel

The key objectives of the Snare Sentinel program was to monitor for the presence of sub-surface oil in nearshore areas that could threaten unoiled, sensitive shoreline and shallow subtidal habitats, and to monitor for the presence of subsurface oil in proximity to previously oiled shorelines caused by remobilization of sediment entrained oil. It was a qualitative presence or absence program designed to detect any oil that moved beneath the surface. Samples were taken primarily from vessels of opportunity or skiffs by contractors from the ICP.

Other qualitative submerged oil sampling programs

Houma ICP had three other qualitative programs for detecting submerged oil or oil on the seabed nearshore. They were designed to drag nets or pom-poms along the seabed and in the subsurface to detect submerged oil or oil at the seabed. These programs ran from June through early August.

USEPA Region 6

The EPA conducted a survey program to collect water and sediment samples from locations along the Louisiana coast. Samples were taken by EPA contractors. As in Region 4, samples were collected from National Coastline Condition Assessment (NCCA) locations and additional sites where oil was observed. A wide range of analyses were conducted, including oil chemistry analyses, dispersant tests and toxicity tests. Pre-impact data is available and monitoring is continuing. The NCCA program is continuous and was in existence before the DWH incident.

E.3 Subsurface Monitoring Unit

The Subsurface Monitoring Unit (SMU) originally operated out of Houma, LA before moving to the UAC in New Orleans, LA in September. A wide range of studies were coordinated by the SMU. These included early surveys conducted from the M/V *Brooks McCall* and M/V *Ocean Veritas*. Studies focused on the water column and a wide range of sampling and data collection techniques were used. The SMU also directed the comprehensive water column and sediment sampling laid out in the Implementation Plan and Operational Annex.

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[1] Forensic Rapid Assessment Team, Rapid Assessment Team, and Hotshot teams took samples of surface oil and oil that washed on shore for characterization.

E.4 Implementation Plan/Operational Annex Sampling

The sampling program detailed in the Implementation Plan (13 September) and refined in the Operational Annex (1 October) was designed to be a hybrid approach that was robust and science driven and that used an adaptive program to fill in gaps between the existing data points to:

1. Monitor and assess the distribution, concentration, and degradation of the portion of the oil that remains in the water column and/or bottom sediments.
2. Evaluate the distribution of indicators of dispersant or breakdown products of dispersants used in oil-spill response activities.
3. Identify any additional response requirements that may be necessary to address remaining subsurface oil.

In the context of the previous sampling, the plan proposed a statistically-based adaptive approach for enhanced sampling in three spatial domains: (a) the *nearshore* from the marshes and beaches (including bays and back-barrier environments) to 3 nmi offshore; (b) the *offshore*, from 3 nmi to the shelfbreak (defined as the 200 m water depth contour); and (c) the *deep water*, from 200 m to about 2,000 m water depth (the well is in 1500 m water depth). The spatial extent of the sampling of shallow waters was guided by previous observations of the extent of oil at the surface (from ships, aircraft, satellites and in situ sampling and observation) and by knowledge of the nearshore physical oceanography (i.e., movement of water and sediments). Sampling in offshore and deep waters was guided by: (a) monitoring results obtained to date, (b) trajectory models for the deep-water layer where hydrocarbons have previously been observed, and (c) a set of hypotheses for likely locations of remaining oil. The effort emphasized enhanced sediment sampling on the continental shelf and in deep water. The location of sampling sites was science driven and included information and input from sampling conducted on academic and non-Response cruises.

Statistical power analyses were conducted to determine sample sizes needed for the evaluation of pre-impact to post-impact periods in the nearshore, where pre-impact data were available. Targeted sampling in specific locations and areas of interest and consideration of both quantitative and qualitative sampling were also incorporated into the design based on theories regarding where oil may have encountered sediment or conditions that may have caused it to sink to the seafloor, such as surface oil encountering sediment laden water in the Mississippi River convergence zone.

Figure E-2. Sediment sample locations completed as part of the Implentation Plan/Operational Annex sampling.

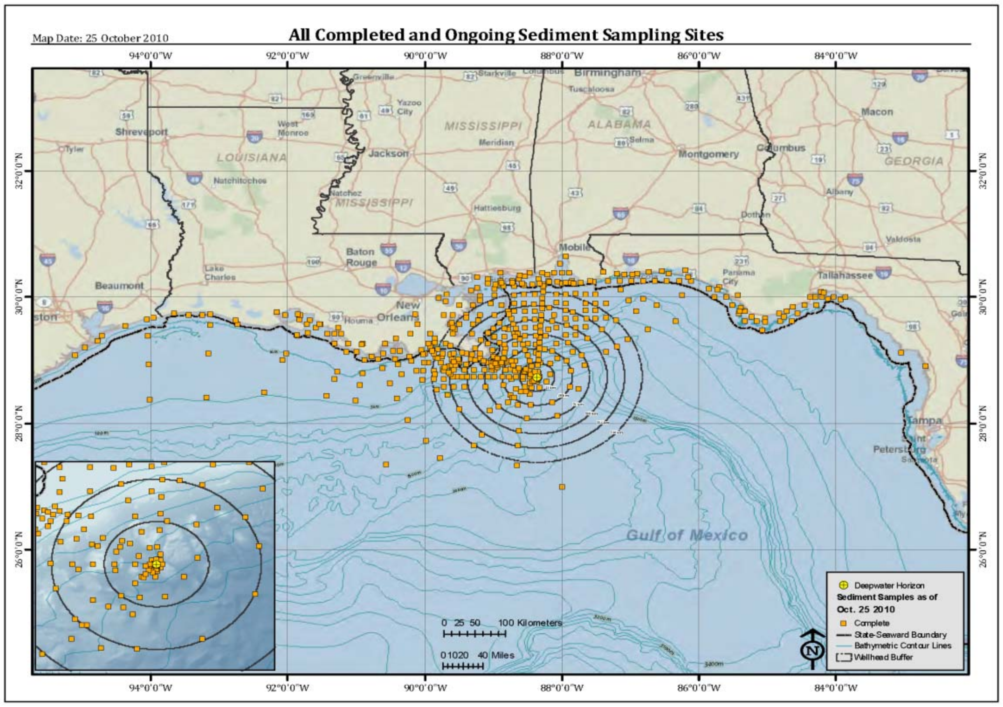
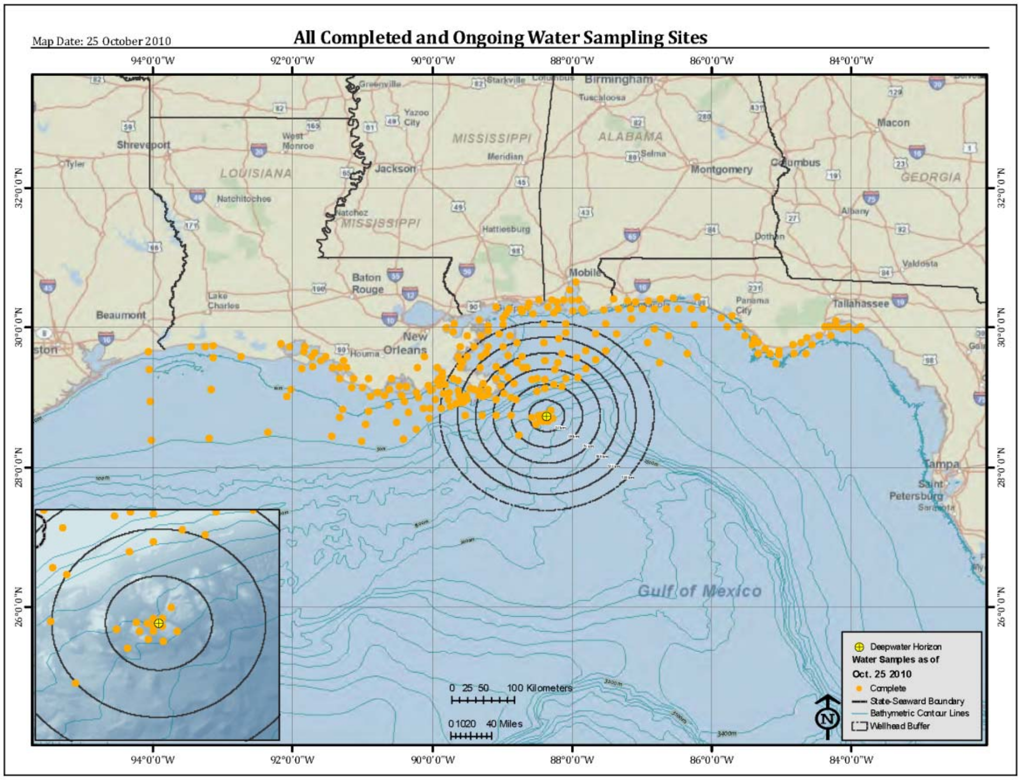


Figure E-3. Water sample locations completed as part of the Implentation Plan/Operational Annex sampling.



Appendix F: OSAT Recommendations, 30 August–01 November 2010

The OSAT analyzed data from the sub-surface and sub-sea monitoring effort and provided the analysis to the Federal On-Scene Coordinator (FOSC). The OSAT also made recommendations on sampling gaps based on data collected and planned execution of the sub-surface monitoring effort. Between 30 August and 01 November 2010, OSAT submitted seven significant recommendations and several minor recommendations to the FOSC via the SSC and EU. This appendix contains the OSAT recommendations and relevant background information. The following table summarizes key OSAT recommendations and outcomes.

Table F.1. Summary of Key OSAT Recommendations and Outcomes

Key OSAT Recommendations (30AUG - 01NOV)	Date of OSAT Recommendation	Outcomes to OSAT Recommendations
Recommendation 1: Discontinue water column sampling in the far field grid (WSW of wellhead).	**20-Sep-2010**	**Outcome**: Recommendation accepted. NRDA sampling may continue but water column effort WSW of wellhead now complete.
Recommendation 2: Conduct more water column sampling in the near field grid (30km circle around wellhead).	**20-Sep-2010**	**Outcome:** Recommendation accepted. Additional sampling locations were established and OSAT sent 15 coordinates to R/V PISCES for sampling which were completed.
Recommendation 3: Future samples should be more thoroughly analyzed. Future sample analysis should include all 43 analytes for PAHs, metals and other organic compounds required for comparison to EPA PAH aquatic life benchmarks in water and sediment samples. In the early stages of the DWH incident response, PAH concentrations were compared to acute exposure benchmarks for aquatic life. During the course of the DWH incident response chronic exposure benchmarks were added due to the longevity of the release.	**20-Sep-2010**	**Outcome**: Recommendation accepted. Sample analysis now includes all 43 analytes for PAH, metals and other organic compoundes. Post-03AUG samples analyzed for 16 analytes are being reanalyzed for 43 analytes.
Recommendation 4: A thorough Scribe data review should be conducted by technical specialists assigned to the Environmental Unit. Scribe data pulls should be continually managed by technical specialists.	**4-Oct-2010**	**Outcome:** Recommendation accepted. A data management branch for Scribe data was established within the Environmental Unit to conduct major QA/QC review of the Scribe metadata to ensure that an accurate and defensible record of sampling and monitoring activities is maintained.
Recommendation 5: OSAT should remain at current staffing levels in anticipation for influx of data. A GIS analyst with Scribe expertise has been assigned by EPA but want to relay to command how vital their function is for the OSAT to report.	**4-Oct-2010**	**Outcome:** Recommendation accepted. A GIS analyst with Scribe expertise has been assigned by EPA and is providing products for OSAT Reports.

Key OSAT Recommendations (30AUG - 01NOV)	Date of OSAT Recommendation	Outcomes to OSAT Recommendations
Recommendation 6: OSAT sees little need in continuing the Snare Sentinel Program as part of the Subsurface Monitoring effort for the response. OSAT recommends phasing out the program beginning with areas that have shown no oiling of snares to date and are not adjacent to oiled shorelines as determined by SCAT.	**18-Oct-2010**	**Outcome:** Recommendation accepted. GCIMT has initiated the phasing out of this monitoring effort.
Recommendation 7: The sediment sampling strategy laid out in the Implementation Plan calls for an adaptive approach based on observations of oil in sediment samples. Based on recent qualitative observations of oil associated with sediment cores from sites offshore of the Mississippi Delta, the OSAT recommends further targeted sampling in this region to determine the extent of the potentially impacted area. Ideally, protocols would be identical to those used for previous sediment sampling; however, if core barrels are limited then sediment chemistry is the priority.	**19-Oct-2010**	**Outcome:** Recommendation accepted. Further targeted sampling in this region was conducted to determine the extent of the potentially impacted area offshore of the Mississippi Delta. Twelve new stations were added.

F.1 20 September Memo #1

OPERATIONAL SCIENCE ADVISORY TEAM MEMORANDUM #1

TO: RADM PAUL ZUKUNFT, FEDERAL ON-SCENE COORDINATOR (FOSC)
THROUGH: EDWIN LEVINE, SCIENTIFIC SUPPORT COORDINATOR (SSC)
FROM: OPERATIONAL SCIENCE ADVISORY TEAM (OSAT)
SUBJECT: RECOMMENDATIONS AND FINDINGS
DATE: SUBMITTED 20SEP2010, UPDATED 28SEP2010
CC: CDR DANIEL NORTON, ASSISTANT ENVIRONMENTAL LEADER, USCG

RECOMMENDATIONS AND FINDINGS

Recommendation 1: Deepwater Sampling Zone, Far Field grids.

OSAT has reviewed and evaluated data collected in association with the Deepwater Horizon response Subsurface Monitoring Activities in the Deepwater Zone, including reports issued by the Joint Advisory Group and recent peer reviewed literature. A summary and discussion of this data review has been drafted. Based on this review, the OSAT found that:

Findings:

1. In far-field subsurface samples, PAH concentrations have never exceeded the acute or chronic aquatic life benchmarks in the 81 samples collected. EPA's benchmarks for PAHs are assessed through a mixture approach, whereby unique potency divisors are specified for 41 different oil-related organic compounds.

2. In far-field subsurface samples, dispersant indicator products (DPNB, Propylene Glycol, 2-Butoxy Ethanol) have never exceeded EPA screening levels .[1]

3. Minimum DO levels in the deep plume were measured on 27 May (4.23 mg L-1; 18 km from wellhead) and 28 July (3.66 mg L-1; 40 km from wellhead). Recent

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[1] The following represent screening levels (based on dissolved seawater concentrations) that may be used to communicate and explain the relevance of measured concentrations of individual dispersant chemical components from Gulf of Mexico waters and that concentrations above these levels are levels of concern. These compounds represent the major constituents of Corexit, those with known toxicology data and those with newly established analytical methods. The screening levels are based on available biological effects data and are designed to conservatively protect aquatic life. Each of these compounds is subject to wide commercial use in other products beyond Corexit 9500. If a screening level is exceeded, the potential for other source(s) of the chemical will be evaluated.

Compound	Detection Limits	EPA Aquatic Life Screening Level
Propylene Glycol	500 ug/L	500,000 ug/L
2-Butoxyethanol	125 ug/L	165 ug/L
Di(Propylene Glycol) - Butyl ether	1 ug/L	100 mg/L acute 1 mg/L chronic
Dioctylsulfosuccinate	20 ug/L	360 ug/L acute 40 ug/L chronic

measurements in the far field have detected DO sags (typically < 1mg L-1) as far as 450 km from the wellhead (to the SW) Minimum DO values measured since mid-August are above 4 mg L-1.

4. The signature of the plume in both fluorescence and DO is becoming attenuated. The subsurface plume has been delineated WSW of the wellhead based on regions where DO readings have sagged and fluorescence peaked at the same time.
5. National Marine Fisheries Service (NMFS) recommends precautionary closures once oil or chemical contaminants are visually observed on the surface. NMFS has maintained a closure in the far field sampling area; oil was last sited mid-July. NMFS has begun to reopen fisheries.

Conclusions:

i. Oil and dispersant break down product concentrations do not exceed screening levels or benchmarks and are decreasing;

ii. Dissolved oxygen levels are above hypoxic thresholds and are not expected to reach hypoxia; and

iii. The movement and extent of the subsurface plume of dispersed oil has been characterized and delineated and is consistent with predictions based on measured and predicted deep ocean currents.

Recommendation: Sufficient water column data has been collected in the far field sampling grids located to the SW of the wellhead (from approx. 100-400 km).

<u>Recommendation 2: Deepwater Sampling Zone, Near Field.</u>

Findings:

In the near field area, the area within 30 km of the Deepwater Horizon wellhead, no water samples have exceeded the acute aquatic life benchmark for PAHs since 22 June. However, samples continued to exceed the chronic aquatic life benchmark through the most recent samples available in Scribe (as of 19 Sep; data collected 22 July). Thus, the chronic benchmark was still being exceeded on July 22nd and more recent data is required to determine whether this is still the case.

Conclusion:

A systematic sampling of this area, coincident temporally and spatially with the upcoming sediment work would provide a comprehensive dataset for comparison with decision indicators. With the permanent sealing of the well, this systematic near field sampling would also provide a post event assessment: a step necessary for meeting response transition points.

Recommendation: OSAT recommends that, concurrent with the Deep water sediment sampling plan, a small number of stations (~25) within 30 km of wellhead should be targeted for water sampling. These stations will be chosen based on co-location with deep water sediment sampling and reoccupation of stations previously observed to have significant exceedances of water quality benchmarks.

Recommendation 3:

In the early stages of the Deepwater Horizon incident response, PAH concentrations were compared to acute exposure benchmarks for aquatic life. During the course of the Deepwater Horizon incident response chronic exposure benchmarks were added due to the longevity of the release.

Finding:

Forty-three analytes are required for comparison to EPA aquatic life and human health benchmarks, which are considered by the OSAT in their recommendation process.

Conclusion: Data being collected for analysis pursuant to the response to the Deepwater Horizon response operation needs to meet current standards for analysis.

Recommendation: Future sample analysis should include all 43 analytes for PAHs, metals and other organic compounds required for comparison to EPA PAH aquatic life benchmarks in water and sediment samples.

F.2 27 September Memo #2

OPERATIONAL SCIENCE ADVISORY TEAM MEMORANDUM #2

TO: EDWIN LEVINE, SCIENTIFIC SUPPORT COORDINATOR (SSC)

FROM: OPERATIONAL SCIENCE ADVISORY TEAM (OSAT)

SUBJECT: RECOMMENDATIONS AND FINDINGS

DATE: 9/27/2010

CC: CDR DANIEL NORTON, ASSISTANT ENVIRONMENTAL LEADER, USCG

RECOMMENDATIONS AND FINDINGS

OSAT continues to engage in data collection and analysis, conducted in accordance with the Subsurface Monitoring Implementation Plan (13 Sept 2010). During the reporting period (beginning 20 Sept 2010), OSAT focused its efforts on the nearshore zone, defined in the plan as the "coast to 3nm." The use of the term "coast" to delineate the landward extent of the zone is not optimal, and an OSAT request for clarification pends with NOAA.

OSAT has received new products created by the Subsurface Monitoring Unit (SMU) that improve visibility of vessels underway and those that are preparing to get under way. These products are helpful and address an existing need. Further improvements would assist the OSAT by providing context for deliberations on decision indicators.

Recommendation 1: Continued Improvements with respect to Communications, Awareness.

Findings: Near real time information regarding vessel locations and activities provides an important context for OSAT deliberations and workflow, and changes to vessel activities may bear on OSAT's work to identify sampling gaps and to do so in a timely manner. OSAT supports improved transparency and data availability within the Environmental Unit, particularly between OSAT and SMU.

Conclusions: In addition to the "just in time" approach that has been applied to cruise planning, lapses in awareness /coordination regarding the sampling strategies of response vessels have resulted in confusion and diminished the efficiency of work products that are rendered moot when work is already in the pipeline or when gaps thought to be addressed, are found to persist.

Recommendation: OSAT requests an advanced (24 hr) briefing or synopsis of cruise and study plans for vessels about to embark on response missions. OSAT also recommends incorporation of a weekly brief on the mission plan of outbound vessels into the 1700 EU meeting.

Recommendation 2: Further water column sampling is required on the shelf.

Findings:

1. A large gap in water sampling remains along and between the corridor regions on the shelf, where only sediment sampling is currently planned.

2. OSAT is aware of at least one mission performing water column sampling in a distinct region of the shelf (i.e., M/V International Peace).

Conclusions: OSAT's decision indicators for the offshore (shelf) include EPA's benchmarks for poly aromatic hydrocarbons (PAHs) and dispersants in the water column. There is currently insufficient data on the shelf to assess whether or not these benchmarks have been met.

Recommendation: OSAT recommends that water sampling profiles for chemical measurements be collected in and between the corridors that are currently planned for sediment sampling. Where sediment sampling is densely spaced, water samples may be collected at a subset of locations.

Recommendation 3: Confirm that NMFS is informed of May/June Benzene exceedance.

Findings:

1. OSAT found that Benzene levels in approximately 20 deepwater samples collected in May and June slightly exceeded a conservative cancer risk guideline EPA recommended for setting state water quality criteria. No samples collected since early June exceeded the guideline for Benzene.

2. OSAT considered this information and does not recommend changes or amendments to its 20 September recommendation regarding farfield monitoring.

Conclusion: The Subsurface Monitoring Implementation Plan indicates that the SSC should communicate information pertaining to seafood safety to NMFS. EPA pulled data to specifically address the identified exceedance and reviewed language drafted by OSAT's NOAA representative, for conveyance to NMFS. OSAT recommends that a specific NMFS liaison be designated to improve communications from OSAT to that agency.

Recommendation: OSAT recommends that the information be communicated to NMFS for confirmation that NMFS already addressed the matter, or else has the OSAT data for further analysis if necessary.

Recommendation 4: Recover data from missing response cruises identified by EPA analysis.

Finding: EPA comparison of data available in the Scribe database and monitoring cruises on file in the Subsurface Monitoring Unit files (attached) reveals cruises for which data has not been loaded into Scribe.

Conclusion: Complete datasets are necessary for OSAT to properly consider results and make well-founded recommendations.

Recommendation: Steps should be taken to recover unreported or unavailable data, or to document and address the cause of the loss of data or visibility.

F.3 29 September Memo #3

OPERATIONAL SCIENCE ADVISORY TEAM MEMORANDUM #3

TO: RADM PAUL ZUKUNFT, FEDERAL ON-SCENE COORDINATOR (FOSC)

THROUGH: CHARLIE HENRY, SCIENTIFIC SUPPORT COORDINATOR (SSC)

FROM: OPERATIONAL SCIENCE ADVISORY TEAM (OSAT)

SUBJECT: SUMMARY OF RECOMMENDATIONS

DATE: 29SEP2010

CC: CDR DANIEL NORTON, ASSISTANT ENVIRONMENTAL LEADER, USCG

SUMMARY OF 20SEP RECOMMENDATIONS

Purpose: To summarize recommendations and findings outlined in OSAT's 20SEP memo to the FOSC.

Recommendation 1: Discontinue water column sampling in the far field grid (WSW of wellhead).

Rationale:

1. Oil and dispersant component concentrations do not exceed screening levels or benchmarks and are decreasing.
2. Dissolved oxygen levels are above hypoxic thresholds and are not expected to reach hypoxia.
3. The movement and extent of the subsurface dispersed oil plume has been characterized, is delineated and is consistent with predictions based on measured and predicted deep ocean currents.
4. Sufficient water column data has been collected in the far field sampling grids located to the SW of the wellhead (from approx. 100-400 km).

Recommendation 2: Conduct more water column sampling in the near field grid (30km circle around wellhead).

Rationale:

1. Based on data reviewed as of 19SEP, the chronic benchmark for PAH was being exceeded on 22JUL. Further analysis is required to determine whether this is still the case.
2. Concurrent with the deepwater sediment sampling plan, a small number of stations (~25) within 30 km of wellhead, collocated with deep water sediment sampling, should be targeted for water sampling. Stations previously observed to have significant exceedances of water quality benchmarks should be chosen.

3. A systematic sampling of this area would provide a comprehensive dataset for comparison with decision indicators. With the permanent sealing of the well, this systematic near field sampling would also provide a post event assessment: a step necessary for meeting response transition points.

<u>Recommendation 3</u>: Future samples should be more thoroughly analyzed.
Rationale:

1. Future sample analysis should include all 43 analytes for PAHs, metals and other organic compounds required for comparison to EPA PAH aquatic life benchmarks in water and sediment samples.
2. In the early stages of the DWH incident response, PAH concentrations were compared to acute exposure benchmarks for aquatic life. During the course of the DWH incident response chronic exposure benchmarks were added due to the longevity of the release.

F.4 30 September Memo #4

OPERATIONAL SCIENCE ADVISORY TEAM MEMORANDUM #4

TO:	RADM PAUL ZUKUNFT, FEDERAL ON-SCENE COORDINATOR (FOSC)
THROUGH:	CHARLIE HENRY, SCIENTIFIC SUPPORT COORDINATOR (SSC)
FROM:	OPERATIONAL SCIENCE ADVISORY TEAM (OSAT)
SUBJECT:	RESPONSES TO QUESTIONS FROM 20SEP
DATE:	30SEP2010
CC:	CDR DANIEL NORTON, ASSISTANT ENVIRONMENTAL LEADER, USCG

RESPONSES TO QUESTIONS FROM THE 20SEP Recommendations

Purpose: To respond to questions from FOSC review of OSAT's 20SEP memo.

Question 1: What are the benchmarks used to test the far field (area WSW of the wellhead) subsurface samples? How many samples are needed?

Response:

1) For a view of the far field area, see attachment (1).
2) The benchmarks used for the far field area are EPA's screening levels for poly aromatic hydrocarbons (PAH). These are assessed through a mixture approach, whereby unique potency divisors are specified for 41 different oil-related organic compounds. See attachment (2) for a discussion of how the PAH screening levels were developed.
3) A benchmark is a conservative value below which adverse effects are unlikely to be observed. Benchmarks are similar to screening levels, but this response has deemed them separate; screening levels for established values and benchmarks for event-specific needs (i.e., dispersant constituents). A full explanation of benchmarks is available in attachment (3).
4) The benchmarks used are available at http://www.epa.gov/bpspill/water-benchmarks.html
5) In far field subsurface samples, PAH concentrations have never exceeded the acute or chronic aquatic life benchmarks in the 81 samples collected.

Question 2: Define EPA screening levels for dispersant indicators.

Response:

1) A screening level is an exposure level below which it is unlikely to cause adverse impacts.
2) There are four dispersant indicators screened for, propylene glycol, 2-Butoxyethanol, Di(Propylene Glycol)-Butyl ether and Dioctylsulfosuccinate. These

indicators can also be found in other products and their presence is only an indicator that dispersant may have been in an area.

3) There are detection limits and EPA aquatic life screening levels set for each of the indicators.
4) Attachment (2) goes into detail about how a screening level is set.
5) Attachment (4) gives detail regarding dispersant indicators.

Question 3: A NMFS closure remains in effect in the far field sampling area, but there is no visible oil. Provide finding of time elapsed since we've had visible MC252 oil.

Response:

1) There has been no observable oil in the far field since at least 04AUG.
    2) Since 22JUL, NOAA has reopened about 52,000 square miles of oil-impacted federal waters in accordance with the re-opening protocol agreed to by NOAA, the U.S. Food and Drug Administration, and Gulf states.
3) Based on data reviewed as of 19SEP, the chronic benchmark for PAH was being exceeded on 22JUL. We do not have sample data for dates later than that; the R/V PISCES is now collecting the samples the OSAT needs. Further analysis is required to determine whether the chronic benchmarks are still being exceeded.

Question 4: Request a conclusion as it pertains to fishery closures, ie. aggressive seafood sampling procedures to facilitate reopening.

Response:

1) Since 22JUL, NOAA has reopened about 52,000 square miles of oil-impacted federal waters in accordance with the re-opening protocol http://sero.nmfs.noaa.gov/sf/deepwater_horizon/attachment1(3).pdf agreed to by NOAA, the U.S. Food and Drug Administration, and Gulf states.
2) Prior to re-opening an area, the protocol requires NOAA to demonstrate the area is oil free, the area has little risk of being re-exposed to oil, and seafood tissue samples collected from within the area have passed both sensory and chemical analysis for hydrocarbons. This protocol involves sensory testing for polycyclic aromatic hydrocarbon (PAH) components of the oil and dispersant along with chemical based testing for PAH as a confirmatory measure.
3) After areas are re-opened NOAA Fisheries Service will maintain a seafood safety monitoring program continuing the collection and testing of seafood to ensure that Gulf seafood remains safe for consumers.

Question 4: Water samples continued to exceed the chronic aquatic life benchmark through the most recent samples available in Scribe (as of 19SEP, data collected 22JUL). Are we still at the chronic level or was 22JUL and end point?

Response:

1) Question 3 response is also related to this question.

2) OSAT outlined a request in Memo #5 to R/V PISCES for more water column sampling near the wellhead. OSAT worked with the Subsurface Monitoring Unit (SMU) to direct the PISCES to the exact coordinates where the chronic levels were found in 22JUL. PISCES is currently collecting those samples and once they are processed in a lab and uploaded into EPA's Scribe database, they will be available for review to determine if more recent samples exceed chronic levels.

<u>Question 5</u>: Standards for analysis of materials for PAH concentrations for comparison with aquatic life and human health have changed during the response. Who changed them and why?

Response:

1) EPA Region 6, Region 4 & Headquarters, in conjunction with Health and Human Services (HHS) and State Health Departments developed benchmarks in a collaborative way to assess potential human health risks from exposure to oil-contaminated water.
2) The higher number of analytes is considered a standard and is more comprehensive than the lower number of analytes.

Attachments:

1) Graphic of near field and far field.
2) Explanation of PAH Screening levels
3) Explanation of Benchmarks
4) Explanation of Dispersant Screening levels

F.5 29 September Memo #5

OPERATIONAL SCIENCE ADVISORY TEAM MEMORANDUM #5

TO:	NOAA SHIP PISCES
THROUGH:	NOAA SUBSURFACE MONITORING UNIT (SMU)
	CHARLIE HENRY, SCIENTIFIC SUPPORT COORDINATOR (SSC)
FROM:	OPERATIONAL SCIENCE ADVISORY TEAM (OSAT)
SUBJECT:	REQUEST FOR WATER SAMPLING NEAR WELLHEAD
DATE:	29SEP2010
CC:	CDR DANIEL NORTON, ASSISTANT ENVIRONMENTAL LEADER, USCG

Purpose: To request new water sampling near the wellhead.

Recommendation 1: OSAT requests the R/V PISCES take 15 water samples near the wellhead during her current cruise.

Rationale:

1) No water samples have been taken in this area since 22JUL.

2) Based on data reviewed as of 19SEP, the chronic benchmark for PAH was being exceeded on 22JUL. Further analysis is required to determine whether there are still any exceedances.

3) 15 stations within 30 km of wellhead were chosen because these stations previously observed to have significant exceedances of water quality benchmarks.

4) A systematic sampling of this area would provide a comprehensive dataset for comparison with decision indicators. With the permanent sealing of the well, this systematic near field sampling would also provide a post event assessment: a step necessary for meeting response transition points.

5) Sufficient water column data has been collected in the far field sampling grids located to the SW of the wellhead (from approx. 100-400 km) and we are not asking for sampling of those areas.

Sampling plan:

Sampling should include bottom and interval water column, as well as at least one (1) and possibly more samples within the 27.70 sigma-θ layer (if present), as the Chief Scientist sees fit. The 27.70 sigma-θ layer is typically found between 1100-1300 meters, it should be calculated from downcast CTD data and targeted for sampling on the upcast. Samples should also be taken where fluorometer peaks and/or DO sags are detected following standard procedure (i.e. one bottle below, middle, and above peak/sag).

Attachments:

1) List of coordinates,

2) Added deepwater near field sampling points,

3) ERMA display of near field and far field areas.

F.6 4 October Memo #6

OPERATIONAL SCIENCE ADVISORY TEAM MEMORANDUM #6

TO:	RADM PAUL ZUKUNFT, FEDERAL ON-SCENE COORDINATOR (FOSC)
THROUGH:	CHARLIE HENRY, SCIENTIFIC SUPPORT COORDINATOR (SSC)
FROM:	OPERATIONAL SCIENCE ADVISORY TEAM (OSAT)
SUBJECT:	SUMMARY OF RECOMMENDATIONS
DATE:	04 OCT 2010
CC:	CDR DANIEL NORTON, ASSISTANT ENVIRONMENTAL LEADER, USCG

SUMMARY OF RECOMMENDATIONS

Purpose:

Summarize completed, in progress and outstanding recommendations.
Provide two new recommendations this week.

Recommendation 1 (COMPLETED): Discontinue water column sampling in the far field grid (WSW of wellhead). **UPDATE:** NRDA sampling may continue but water column effort WSW of wellhead now complete.

Recommendation 2 (COMPLETED): Conduct more water quality sampling in the near field grid (30km circle around wellhead). **UPDATE:** OSAT sent 15 coordinates to R/V PISCES for sampling which were completed.

Recommendation 3 (COMPLETED): Sample analysis

Findings: Future sample analysis should include all 43 analytes for PAH, metals, and other organic compounds required for comparison to EPA PAH aquatic life benchmarks in water and sediment samples.

Recommendation: Future samples should be more thoroughly analyzed. **UPDATE:** This is now being completed onshore.

Recommendation 4 (NEW): Analytical Chemistry Data Management

Findings:

- There are significant errors and omissions in the metadata (such as information on sample location and depth) associated with sediment and water samples collected for PAH (and other?) analysis.
- There are no known errors in the analytical chemistry data (laboratory data) on PAH concentrations.

Recommendation:

A major QA/QC review of the Scribe metadata is needed to ensure that an accurate and defensible record of sampling and monitoring activities is maintained. A data management branch for Scribe data is needed within the Environmental Unit.

- Due to the importance of data management, Memo #8, forthcoming, is dedicated fully to this recommendation.

<u>Recommendation 5 (NEW, IN PROGRESS ALREADY):</u> Staffing levels and GIS analyst

Findings:

- There is a lag time between when a sample is collected to the time the data are ready for analysis. This lag time can be up to two months. OSAT anticipates a flood of data as the labs catch up with sample processing. In anticipation of this flood of data, a GIS analyst was requested from EPA under the PRFA to produce maps for regular reporting.
- It should display exceedances and other (non-detects + below benchmark).
- Separate maps may be needed for sediments and water.
- Depending on the resolution of the data, separate maps may be needed for different geographic regions.

Recommendation: OSAT should remain at current staffing levels in anticipation for influx of data. A GIS analyst with Scribe expertise has been assigned by EPA but want to relay to command how vital their function is for the OSAT to report.

Attachment: Display of near field and far field areas.

F.7 4 October Memo #7

OPERATIONAL SCIENCE ADVISORY TEAM MEMORANDUM #7

TO:	RADM PAUL ZUKUNFT, FEDERAL ON-SCENE COORDINATOR (FOSC)
THROUGH:	CHARLIE HENRY, SCIENTIFIC SUPPORT COORDINATOR (SSC)
FROM:	OPERATIONAL SCIENCE ADVISORY TEAM (OSAT)
SUBJECT:	DATA MANAGEMENT RECOMMENDATIONS
DATE:	04 OCT 2010
CC:	CDR DANIEL NORTON, ASSISTANT ENVIRONMENTAL LEADER, USCG

ANALYTICAL CHEMISTRY DATA MANAGEMENT

Purpose: To recommend a review and ongoing maintenance of Scribe data by technical specialists.

Recommendation 4 (NEW): A thorough Scribe data review should be conducted by technical specialists assigned to the Environmental Unit. Scribe data pulls should be continually managed by technical specialists.

Findings:

- Critical field and analytical data from surface and subsurface monitoring activities are being managed using the Scribe database.
- There are significant errors and omissions in the metadata (such as information on sample location and depth) associated with sediment and water samples collected for PAH (and other) analysis.
- Data pulled from Scribe by the OSAT are inconsistent - data available one day is not retrieved on subsequent pulls. The reason for this inconsistency is unknown. Potential explanations include: instability in the underlying data structure, changes in query methods used by rotating data support personnel, or QA/QC activities of which the OSAT is unaware.
- A large influx of new data into Scribe from current and planned sampling activities is anticipated within the next several weeks.
- The OSAT has been unable to confirm that a systemic QA/QC process is in place for data in Scribe.
- The OSAT has been unable to locate a central point of overall responsibility for maintaining the Scribe database for this response.

Recommendation:

The Environmental Unit should conduct a major QA/QC review of the Scribe metadata to ensure that an accurate and defensible record of sampling and monitoring activities is maintained. The existing pool of Scribe technical specialists should be increased in order to conduct this review. These technical specialists should conduct a major QA/QC review of the Scribe data, metadata and data architecture and work with the OSAT and other parties requiring access to Scribe to develop robust and consistent queries. These activities are required for the OSAT to have confidence in its analysis of analytical data and to ensure that an accurate and defensible record of sampling and monitoring activities conducted by this response is maintained.

F.8 4 October Memo #8

OPERATIONAL SCIENCE ADVISORY TEAM MEMORANDUM #8

TO:	RADM PAUL ZUKUNFT, FEDERAL ON-SCENE COORDINATOR (FOSC)
THROUGH:	CHARLIE HENRY, SCIENTIFIC SUPPORT COORDINATOR (SSC)
FROM:	OPERATIONAL SCIENCE ADVISORY TEAM (OSAT)
SUBJECT:	RECOMMENDATION FOR A DATA MANAGEMENT BRANCH
DATE:	04 OCT 2010
CC:	CDR DANIEL NORTON, ASSISTANT ENVIRONMENTAL LEADER, USCG

DATA MANAGEMENT

Purpose: To recommend a review of Scribe data and create a Scribe data management unit.

Recommendation 4 (NEW): Analytical Chemistry Data Management

Findings:

- Critical field and analytical data from surface and subsurface monitoring activities are being managed using the Scribe database.
- There are significant errors and omissions in the metadata (such as information on sample location and depth) associated with sediment and water samples collected for PAH (and other) analysis.
- Data pulled from Scribe by the OSAT are inconsistent - data available one day is not retrieved on subsequent pulls. The reason for this inconsistency is unknown. Potential explanations include: instability in the underlying data structure, changes in query methods used by rotating data support personnel, or QA/QC activities of which the OSAT is unaware.
- The overwhelming majority of the chemical analyses conducted thus far have detected no measurable concentration of PAH's. A similarly large percentage of the samples with detectable quantities of PAH's have been below the benchmark levels for these chemicals.
- A large influx of new data into Scribe from current and planned sampling activities is anticipated within the next several weeks.
- The OSAT has been unable to confirm that a systemic QA/QC process is in place for data in Scribe.
- The OSAT has been unable to locate a central point of overall responsibility for maintaining the Scribe database for this response.
- Due to the small number of samples exceeding benchmark levels, the OSAT is able to perform its mission without concern for the overall quality of the metadata.

Recommendation:

The Environmental Unit should conduct a major QA/QC review of the Scribe metadata to ensure that an accurate and defensible record of sampling and monitoring activities is maintained. A Scribe data management unit should be created within the ICS. This unit should be charged with conducting a major QA/QC review of the Scribe data, metadata and data architecture and working with the OSAT and other parties requiring access to Scribe to develop robust and consistent query’s. These activities are required for the OSAT to have confidence in its analysis of analytical data and to ensure that an accurate and defensible record of sampling and monitoring activities conducted by this response is maintained.

F.9 11 October Memo #9

OPERATIONAL SCIENCE ADVISORY TEAM MEMORANDUM #9

TO:	STEVE LEHMANN, SCIENTIFIC SUPPORT COORDINATOR (SSC)
THROUGH:	CDR DANIEL NORTON, ASSISTANT ENVIRONMENTAL UNIT LEADER, USCG
FROM:	OPERATIONAL SCIENCE ADVISORY TEAM (OSAT)
SUBJECT:	SUMMARY OF OSAT RECOMMENDATIONS AND ACTIVITIES
DATE:	11 OCT 2010
CC:	JOHN BENNINGTON, ENVIRONMENTAL LEADER

SUMMARY OF RECOMMENDATIONS

Purpose: Summarize completed, in progress and outstanding recommendations.

Recommendation 1 (COMPLETED): Water column sampling effort in far field (greater than 30km WSW) of wellhead now complete.
Recommendation 2 (COMPLETED): Conduct more water quality sampling in the near field grid (30km circle around wellhead). **UPDATE:** All deep water column sampling completed.
Recommendation 3 (COMPLETED): All sample analysis include the 43 analytes for PAH, metals, and other organic compounds required for comparison to EPA PAH aquatic life benchmarks in water and sediment samples.
Recommendation 4 (IN-PROGRESS): A major QA/QC review of the Scribe metadata is needed to ensure that an accurate and defensible record of sampling and monitoring activities is maintained. As a result, a data management branch for Scribe data was established within the Environmental Unit..
Recommendation 5 (COMPLETED): A GIS analyst with Scribe expertise has been assigned by EPA and is providing products for Status Reports.

SUMMARY OF OSAT ACTIVITIES

Purpose: Summarize OSAT activities for the past week.

In anticipation of the data influx that will occur once Activities 1 and 2 (from the Operational Annex) are completed, OSAT has been working to standardize data output from Scribe and resolve problems from inconsistent data entry. Other issues include changes caused by the recent geo-labeling update, where all unique sample IDs were linked to a particular zone (nearshore, offshore, or deepwater), and the continuing validation of data in Scribe. Currently, only approximately 59% of Scribe data has undergone QA/QC which may result in fluctuations between current and future results. OSAT continues to work with our EPA Scribe contractors and the BP Exponent contractors, as well as

Environmental Standards, to produce the highest quality data analysis possible. In addition, OSAT has been working with our dedicated GIS person to develop map products to include in future Status Reports to the SSC and for eventual upload to ERMA.

F.10 18 October Memo #10

OPERATIONAL SCIENCE ADVISORY TEAM MEMORANDUM #10

TO:	RADM PAUL ZUKUNFT, FEDERAL ON-SCENE COORDINATOR (FOSC)
THROUGH:	STEVE LEHMANN, SCIENTIFIC SUPPORT COORDINATOR (SSC)
FROM:	OPERATIONAL SCIENCE ADVISORY TEAM (OSAT)
SUBJECT:	RECOMMENDATION FOR SNARE SENTINAL PROGRAM
DATE:	18 OCT 2010
CC:	CDR ANDREW TUCCI , ASSISTANT ENVIRONMENTAL LEADER, USCG

REVIEW OF LOUISIANA SNARE SENTINEL PROGRAM

Findings:

- Observational Snare Sentinel data was analyzed for the period 28 July to 2 October. Oil observations were infrequent, with <1% of Snare Sentinel retrievals showing any degree of oiling (40 of 6911 retrievals).

- Oil was detected at 7.1% of Snare Sentinel sites (32 of 449). Five of the total number of sites were oiled more than once. Of these five sites, the highest percentage of oiling was 19% (3 detects in 16 retrievals at one site).

- Oil detections have decreased significantly.
    - Last surface detection was 31 July in Barataria Bay (78 days ago).
    - Last sub-surface detection was 20 September in Barataria Bay (28 days ago).

- All observations of sub-surface oiling have been located off previously oiled shorelines – weathering and biodegradation patterns from these observations indicate that this oil originated from surface oil that was mixed with sediments, became heavier than water, sank and was remobilized.

- Any future detection of subsurface MC252 oil by Snare Sentinels would most likely be due to remobilization of oil already present in the nearshore environment – i.e. in known regions of heavily oiled shorelines.

Recommendation:

Based on these findings, OSAT sees little need in continuing the Snare Sentinel Program as part of the Subsurface Monitoring effort for the response. OSAT recommends phasing out the program beginning with areas that have shown no oiling of snares to date and are not adjacent to oiled shorelines as determined by SCAT.

F.11 19 October Memo #11

OPERATIONAL SCIENCE ADVISORY TEAM MEMORANDUM #11

TO: RADM PAUL ZUKUNFT, FEDERAL ON-SCENE COORDINATOR (FOSC)

THROUGH: STEVE LEHMANN, SCIENTIFIC SUPPORT COORDINATOR (SSC)

FROM: OPERATIONAL SCIENCE ADVISORY TEAM (OSAT)

SUBJECT: RECOMMENDATION FOR ADDITIONAL OFFSHORE SEDIMENT SAMPLING

DATE: 19 OCT 2010

CC: CDR ANDREW TUCCI, ASSISTANT ENVIRONMENTAL LEADER, USCG

ADDITIONAL SEDIMENT SAMPLING IN MS RIVER CONVERGENCE ZONE

Findings:

1. Sensory inspection of 5 sediment cores obtained by the R/V Ocean Veritas between 5-10 October has indicated potential presence of oil (visible sheen associated with sediment or overlying water).

2. The five sample sites are located approximately 15-30 km offshore of the Mississippi Delta. This region was identified in the Implementation Plan as having a higher likelihood of transport of surface oil to the bottom, due to interaction of surface oil with the sediment laden Mississippi River plume in regions of freshwater convergences.

3. There are a number of known seeps and other potential sources of oil located in the vicinity of these sample sites (within 10-20 km). Further sampling and forensic chemistry will determine the source of the observed oil.

Recommendation:

The sediment sampling strategy laid out in the Implementation Plan calls for an adaptive approach based on observations of oil in sediment samples. Based on recent qualitative observations of oil associated with sediment cores from sites offshore of the Mississippi Delta, the OSAT recommends further targeted sampling in this region to determine the extent of the potentially impacted area. Ideally, protocols would be identical to those used for previous sediment sampling; however, if core barrels are limited then sediment chemistry is the priority.

Attachments: Existing and proposed sampling locations

F.12 26 October Memo #12

OPERATIONAL SCIENCE ADVISORY TEAM MEMORANDUM #12

TO:	RADM PAUL ZUKUNFT, FEDERAL ON-SCENE COORDINATOR (FOSC)
THROUGH:	CHARLIE HENRY, SCIENTIFIC SUPPORT COORDINATOR (SSC)
FROM:	OPERATIONAL SCIENCE ADVISORY TEAM (OSAT)
SUBJECT:	RECOMMENDATION FOR A DATA MANAGEMENT GROUP
DATE:	26 OCT 2010
CC:	CDR ANDREW TUCCI , ASSISTANT ENVIRONMENTAL LEADER, USCG

DATA MANAGEMENT GROUP TO RESOLVE DATA ISSUES

Findings:

- Inconsistencies with data uploaded to Scribe by data originators continue to hamper OSAT’s ability to provide data analysis products. Roughly 20% of the data entries within Scribe have at least one major problem and 25% of the data has not gone through QA/QC review.
- Until the identified issues have been resolved, OSAT and other end users of Scribe cannot analyze response data with a satisfactory level of confidence in the results.
- The major issues discovered to date are in two groups: 1) Location (absent or improperly reported latitude and longitude and missing depth values) and 2) Duplicates (analytes not being reported in a standard way causing duplicate analytes, and upload issues that cause multiple entries for one sample).
- The vast majority of issues with data in Scribe are outside of the purview of OSAT’s Scribe data manager to remedy, and consequently can only be resolved by engaging with data originators and intermediate databases.
- OSAT’s Scribe data manager (an EPA START contractor) has compiled a list of these issues (attached).

Recommendation:

The magnitude and urgency of this problem requires establishing a Data Management Group to 1) resolve data problems found by OSAT, 2) enforce the use of the Data Dictionary by all providers of response data, and 3) proactively search for problems and provide solutions. Given the pace of ongoing response activities, it is necessary that this recommendation be implemented **within two weeks** of today’s date to avoid negatively impacting the response. The resolution of these issues needs to be a priority for all parties (both government and BP), especially those who are data originators and those who have contracted data originators to provide data to Scribe for the response. OSAT further recommends that this group report to the Deputy Planning Section Chief –Environmental and the Environmental Unit Leader. The membership of this Data Management Group should be determined by the Environmental Unit (EU) with some OSAT input and may be expanded as needed to quickly and efficiently solve the listed problems. At a minimum it needs to include OSAT's data manager, an EPA START contractor, and BP personnel and contractors from the data management/sample tracking section and the data quality assurance section of the EU. Also, a NOAA data manager and an EPA representative are requested to be members.

Appendix G: List of Acronyms

ADCP	Acoustic Doppler Current Profilers
AOR	Area of Responsibility
AUV	Autonomous Underwater Vehicle
BOEMRE	Bureau of Ocean Energy Management, Regulation, and Enforcement
BTEX	Benzene, Toluene, Ethylbenzene, and Xylene
CEQ	Council on Environmental Quality
CO-OPS	Center for Operational Oceanographic Products and Services
COP	Common Operating Picture
CTD	Conductivity, Temperature and Depth
CTEH	Center for Toxicology and Environmental Health, LLC
DIF	Data Integrated Format
DO	Dissolved Oxygen
DOI	Department of Interior
DOSS	Dioctylsulfosuccinate Sodium Salt (a dispersant-related chemical)
DPnB	Di(Propylene Glycol) Butyl Ether (a dispersant-related chemical)
DRO	Diesel Range Organic
DWH	Deepwater Horizon
EPA	Environmental Protection Agency
ERMA	Environmental Response Management Application
FDA	Food and Drug Administration
FORT	Fate of Oil Research Team
FOSC	Federal On-Scene Coordinator
FWS	Fish and Wildlife Service
GC/MS	Gas Chromatography/Mass Spectrometry
GCOOS	Gulf of Mexico Coastal Ocean Observing System
GIS	Geographic Information System
GOM	Gulf of Mexico
GRO	Gasoline Range Organic
IOOS	Integrated Ocean Observing System
JAG	Joint Analysis Group

MC252	Mississippi Canyon, Block 252
MMS	Minerals Management Service
NCCA	National Coastal Conditions Assessment
NCDDC	National Coastal Data Development Center
NCP	National Contingency Plan (40 CFR 300)
NDBC	National Data Buoy Center
NIC	National Incident Command
NMFS	National Marine Fisheries Service (NOAA)
NOAA	National Oceanic and Atmospheric Administration
NODC	National Ocean Data Center
NPS	National Park Service
NRDA	Natural Resource Damage Assessment
NSF	National Science Foundation
NSF	National Strike Force (USCG)
OGC	Open Geospatial Consortium
OPA90	Oil Pollution Act of 1990
ORO	Oil Range Organic
ORR	Office of Response and Restoration (NOAA)
OSAT	Operational Science Advisory Team
OSTP	Office of Science and Technology Policy
PAH	Polycyclic Aromatic Hydrocarbon
QA/QC	Quality Assurance/Quality Control
QAPP	Quality Assurance Project Plan
SDF	Standard Data Format
SMB	Sub-surface Monitoring Branch
SMU	Sub-surface Monitoring Unit
SOS	Sensor Observation Service
SSC	Scientific Support Coordinator
SVOC	Semi Volatile Organic Compounds
UAC	Unified Area Command
UNOLS	University-National Oceanographic Laboratory System
USCG	United States Coast Guard

USGS	United States Geological Survey
USPHS	United States Public Health Service
VIPERS	Vessels with Petroleum Ensnaring and Recovery Systems
VOC	Volatile Organic Compounds
VSP	Visual Sample Plan

Appendix H: OSAT Membership

The Operational Science Advisory Team (OSAT) is a small group of agency representatives, or members, located at Deepwater Horizon Unified Area Command, within the Environmental Unit. The Unified Area Command operates under the direction of the Coast Guard's Federal On-Scene Coordinator. The Environmental Unit is under the operational control of the National Oceanic and Atmospheric Administration. OSAT acts as an advisory board, providing a cross-agency perspective based on near real-time analysis of data from the sub-surface and sub-sea monitoring effort to inform operational decision making.

Composition**:** Six scientific specialties were identified to coordinate daily analysis of data, trends and other considerations, based on the framework established by the Subsurface Monitoring Implementation Plan. Specialties were been further matched to agencies to provide the expertise needed to quickly and efficiently process the data.

Oceanography – NOAA (Lead)

General Environmental Science – US Coast Guard

Coastal Science and oil/contaminant chemistry – BP

Sedimentary Geology – US Geologic Survey

Microbiology – BOEMRE

Chemistry/toxicology – EPA

OSAT is also supported by staff from the U.S. Coast Guard (administrative support and coordination) and a data management specialist working under the auspices of NOAA. Below is the list of individual members of the OSAT.

Agency	OSAT Member	Email
NOAA	Amy MacFadyen	amy.macfadyen@noaa.gov
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The members of the OSAT would also like express our gratitude to the many other individuals who supported us from early participation in organizing efforts and throughout the development and review process by providing discussion, data management support and the production of plots, graphs and maps. This report would not have been possible without your support.