Deepwater Horizon Oil Spill (DWHOS)
Water Column Technical Working Group

NRDA Summer 2011 Epipelagic Plankton Bongo & Neuston Sampling Cruise Plan

Sampling Vessel: M/V *Bunny Bordelon*

July 19, 2011

Prepared by:

Deborah French-McCay, Melanie Schroeder, Eileen Graham, Erin Bohaboy (ASA) and David Wells (NOAA) on behalf of the Trustees

Reviewed by:

NOAA: Dan Hahn, John Quinlan (NOAA)
Louisiana: Amanda Vincent (LA)
William Graeber, Amy Piko, Jeffrey Simms, Julie Keister (Cardno ENTRIX) and Joyce Miley (BP) on behalf of BP.

Cruise Dates

July 18 – September 30, 2011 (Labor Day Break: September 2-5)

Leg 1: July 18 – July 31 (14 DAS)
Leg 2: August 3 – August 16 (14 DAS)
Leg 3: August 19 – September 1 (14 DAS)
Leg 4: September 7 – September 18 (11 DAS)
Leg 5: September 21 – September 30 (9 DAS)

Background/Justification

Conceptual Model – Water Column Organisms

The trustees have developed a preliminary conceptual model of the DWH release, potential pathways and routes of exposure, and potential receptors. This preliminary model has informed the trustees' decision to pursue the studies outlined in the work plan. By signing this work plan and agreeing to fund the work outlined, BP is not endorsing the model articulated in the work plan nor is BP endorsing the full geographic extent of sampling or the rationale provided for it.

Release and Pathway

Oil released from the broken well head both dispersed at depth and rose through nearly a mile of water column. The composition of the released gas-liquid mixture changed over time and space as the result of dilution, changes in pressure, dissolution, and addition of other constituents such as dispersants, methanol, and anti-foaming additives. Of oil that made it to the water surface, some entrained water forming mousse, was dispersed into the water column naturally and by application of dispersants, and some was removed mechanically or by in situ burning. Floating oil, oil droplets, flocculated and dissolved components were transported large distances at various levels of the water column. Oil also picked up sediments, and other particulate material, some of which became neutrally or slightly negative buoyant, sinking to various depths. The oil dispersed at the wellhead (both via turbulence or by injection of dispersants) was transported by currents that varied in time and space, yielding a complex pathway of

subsurface oil contamination that affected abyssal, bathypelagic, and meso-pelagic waters of the offshore Gulf of Mexico.

Routes of Exposure

Fish and invertebrates in the water column are exposed to contaminants by swimming through contaminated water, spending time on/in contaminated sediments, taking up contaminants through body surfaces, passing contaminated water over respiratory structures, and ingesting water, oil droplets, contaminated biota, and particulates contaminated with oil as part of feeding. Additionally, sensitive life stages of pelagic fish and invertebrates come in direct contact with floating oil that covers and is mixed into the neuston layer (upper ~0.5m) where many embryos and larvae develop. Other neustonic organisms exposed to surface oil include many small invertebrates important to the food web. In the water column, organisms are also exposed to suspended oil droplets, which can foul appendages or other body surfaces. Water column organisms have also been exposed to dispersants dissolved in water, on oil droplets and adsorbed to suspended particulate matter. Water column organisms were also exposed to dissolved and water-borne chemical additives such as methanol and anti-foaming agents.

Plankton in the north-eastern Gulf of Mexico, which include early life history stages of fish and invertebrates, as well as smaller invertebrate holo-plankton and gelatinous zooplankton, are among those biota exposed to the released oil and spill-related chemicals. Planktonic organisms throughout the water column of deep offshore slope areas were potentially exposed, including the deeper depth strata where sub-surface oil has been observed (i.e. 1000-1300m). Figure 1 shows the approximate extent of oil observed on the water surface using radar data, which indicates some areas potentially affected by floating oil. Figure 2 shows a cumulative summary of fluorescence measurements between 1000 and 1500m, indicating a possible southwestward transport of the oil and some locations where plankton may have been exposed in deepwater (laboratory analyses to establish whether or not these measurements are linked to MC252 oil have not yet been conducted).

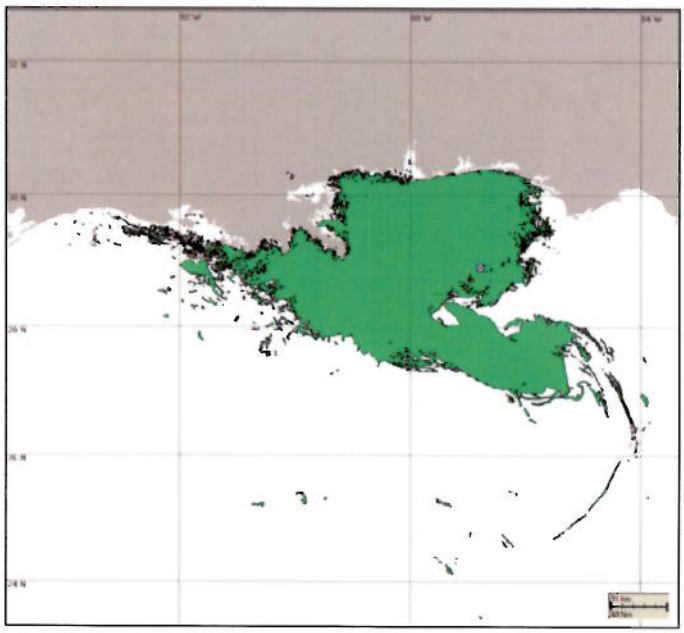

Figure 1. Cumulative potential surface floating oil extent of the Deepwater Horizon oil spill. (Figure derived from compositing April, May, June, and July 2010 radar shape files available on the NOAA ERMA website. Note that radar images with noted anomalies were not included in composite.)

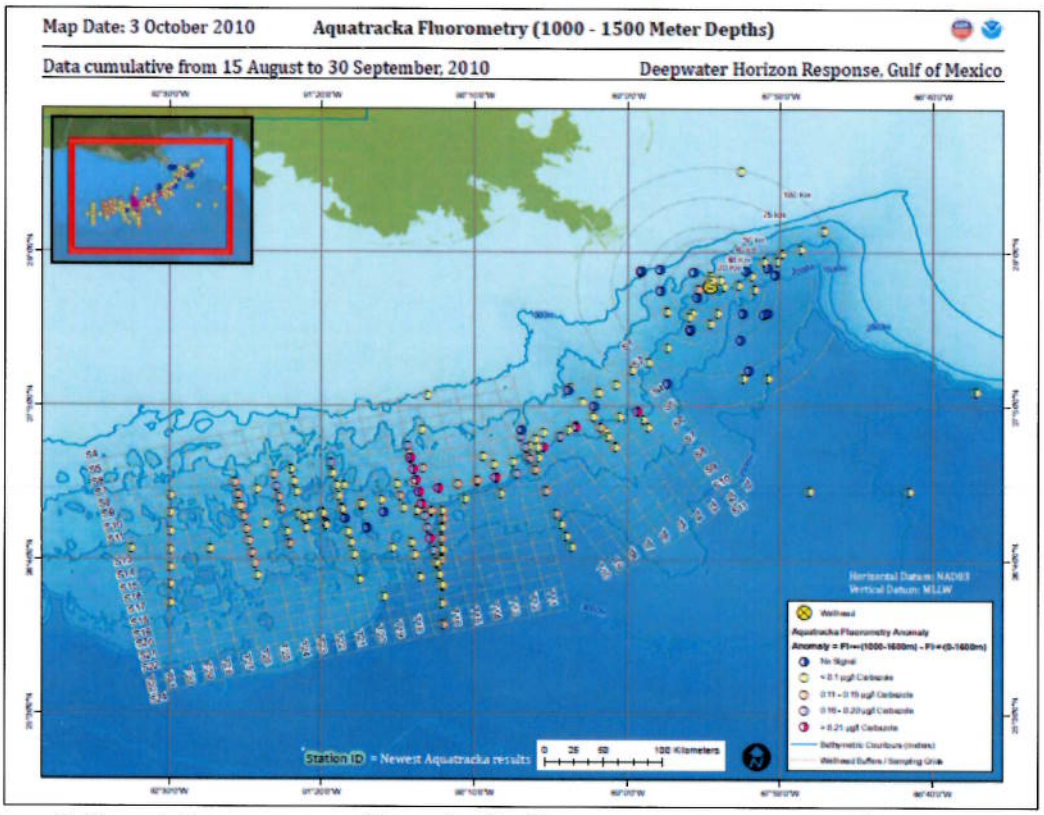

Figure 2. Cumulative summary of Aquatracka fluorescence measurements between 1000 and 1500m, 15 August to 30 September 2010.

Summary of Historical Shelf and Offshore Plankton Data

Plankton in the upper 200m of the water column of the Gulf of Mexico off of Texas to Florida have been sampled by the NMFS/NOAA SEAMAP program over the past ~25 years (Attachment 1). This program offers a significant resource for understanding the characteristics of the natural state of this community. This is augmented by several state-based surveys that sample in waters closer to shore.

Historically SEAMAP plankton samples (bongo/neuston) collected during the summer months (June, July, and early August) occur as part of the Summer Groundfish trawl survey. The Groundfish survey is a collaborative effort between state partner and NMFS vessels. Each summer 400 randomly generated stations are sampled throughout established "statistical zones" that stretch from the Texas shelf to the Florida shelf. These stations are divided up amongst the state partners and NMFS based on distance from shore and logistical factors such as available days at sea and state resources. This is not a dedicated plankton survey like the gridded Spring, Fall, and Winter SEAMAP surveys conducted by the NMFS Southeast Fisheries Science Center (SEFSC), rather a dedicated trawling effort with plankton sampling as a second priority. The stations (and station type) where plankton sampling occurs varies by state partner. For example Louisiana has historically sampled plankton at both several random trawl stations and at seven gridded SEAMAP plankton stations near the coast. Florida does not conduct any plankton sampling as part of the groundfish survey. Historically NMFS Summer Groundfish vessels have attempted to sample plankton at several of the standard SEAMAP gridded plankton stations focusing

effort mainly off the Texas and western Louisiana shelf (no stations offshore). Typically only 30 to 50 stations get sampled during the gulfwide SEAMAP Summer Groundfish survey, and this effort is concentrated to the west of the DWHOS region of interest. Figure 5 in Attachment 1 pictures the historical cumulative plankton sampling effort as part of the Summer Groundfish survey from 1982-2008.

The Fall SEAMAP survey is a dedicated plankton sampling effort conducted by NMFS Southeast Fisheries Science Center (SEFSC). The Fall survey has been running from 1986-present and is conducted from late August to mid-October. There is an established "standard" survey cruise track (Attachment 1, Figure 3), that stretches from the Texas shelf to the Florida shelf. Attachment 1 summarizes the historical and current datasets for plankton fish and crustaceans.

Objectives and Approach

This plan is part of a series of cruises scheduled for the summer of 2011 intended to evaluate the distribution and densities of ichthyoplankton and other zooplankton in Gulf of Mexico waters potentially affected by the Deepwater Horizon Oil Spill (DWHOS) and in surrounding areas. The overall NRDA plankton sampling plan takes advantage of the historical SEAMAP data sets and plans for continuation and extension of the SEFSC SEAMAP program into deep water areas where the spill took place.

This plan, the NRDA Summer Epipelagic Plankton survey, describes the NRDA survey for summer 2011 where a subset of the SEAMAP stations have been selected for sampling ichthyo- and other plankton in the upper water column (i.e., epipelagic). The primary objective of the NRDA survey is to assess the occurrence, abundance, and distribution of the early life stages of fishes in the north central Gulf of Mexico, commercially important invertebrates (lobsters, decapods) and other zooplankton found in the surface waters <200m. Ichthyo- and other zooplankton in the upper water column will be sampled using paired bongo nets, and at the water surface with a rectangular neuston net (SEAMAP standard) and a manta neuston net (CalCOFI standard). The deployment of deep bongo tows (in the upper 200m) and surface neuston tows are those used in the SEAMAP program. In addition to the standard SEAMAP sampling regime, shallow bongo tows and manta neuston net tows will be conducted.

Natural tracers may be used to evaluate food web structure and examine any potential changes in organic source contributions and trophic relationships following the Deepwater Horizon spill. A sub-sample of collections from the spring and summer cruises will be taken to potentially investigate pelagic food webs using natural tracers, $\delta^{13}C$ and $\delta^{15}N$ stable isotopes, of organism processes. Baseline data exists in previous research by Wells and Rooker (2009) for offshore areas of the northern Gulf during 2007 and 2008; in addition, unpublished data for 2009 exists (D. Wells, personal communication). Once collected, these samples can be frozen and archived for future processing and analysis. BP has not had the opportunity to understand this effort but since the collection of samples during this cruise is a minor objective and will not slow down the approved data gathering, the collection of these samples will be supported and BP will work with the trustees to understand the historical data and proposed future data processing and analysis. BP will look forward to further opportunities to discuss both the rationale and designs for both the sampling and analysis of stable isotopes as part of the injury assessment.

This plan will be implemented consistent with existing trustee regulations and policies. All applicable state and federal permits must be obtained prior to conducting work.

Attachment 2 provides SOPs for the protection and conservation of marine mammals and any species listed under the Endangered Species Act as appropriate for the vessel and sampling equipment operations to be conducted on this cruise.

Methodology

Sampling Stations

The cruise track and selected station array for the NRDA M/V *Bunny Bordelon* summer survey is designed to attain data at offshore and inshore stations, to perform more sampling in the deep water areas, and to ensure complete coverage of the area sampled during the winter and spring 2011 surveys (Figure 3). Due to the extent of the area potentially affected by oil and the Trustees desire to sample areas connected hydrodynamically as well as reference areas in similar shelf and offshore environments, stations will be sampled on and beyond the shelf region off the coast of Louisiana, Mississippi, Alabama, and Florida. This station configuration encompasses surface waters that are potentially influenced by major physical factors in the Gulf, e.g., the Mississippi River discharge and the Gulf Loop Current. Stations on the Florida shelf were included as those areas show higher (chlorophyll) productivity in satellite color imagery, are connected hydrodynamically to at least part of the spill-affected area, and are thought to be important grouper spawning grounds.

The cruise schedule allows for 62 days at sea (DAS), considering the breaks between legs. There are 125 proposed sampling locations for summer 2011. Based on the sampling schedule of the spring 2011 survey, approximately 3 – 4 stations can be sampled each 24-hour cycle if time of day for the sampling is not constrained (with the exception of no sampling around dusk/dawn, see below). Thus, the cruise plan allows for sampling at least once at each station, and some stations might be sampled both day and night. Details of this strategy are described below.

This particular effort is being developed as a cooperative program, but is ultimately Trustee-led as required by OPA regulations. As such, these cruises will be led at sea by a Trustee-appointed Chief Scientist who serves as a Trustee representative. This Chief Scientist will work to ensure that cruise objectives are met and that time at sea is utilized efficiently for collecting information pertinent to the investigation. When not on duty, the Chief Scientist will designate a Watch Lead. This Watch Lead will also be a Trustee representative. The Chief Scientist may be supported on-board by a senior scientist appointed by the Responsible Parties. This senior scientist is to consult with the Chief Scientist on logistical and scientific matters, but ultimate decision making authority rests with the Chief Scientist. The Chief Scientist will also consult as needed with shore-side Trustee support (i.e., Drs. French McCay, Hahn, and Quinlan).

The Captain and Chief Scientist will confer regarding the operational plan and schedule, and any changes to the plan or schedule that are required due to logistics, breakdowns or weather concerns. The Chief Scientist will be responsible for notifying the designated NOAA and RP leads regarding schedule changes, so that each lead may notify staff and adjust their respective staff mobilization schedules, as needed.

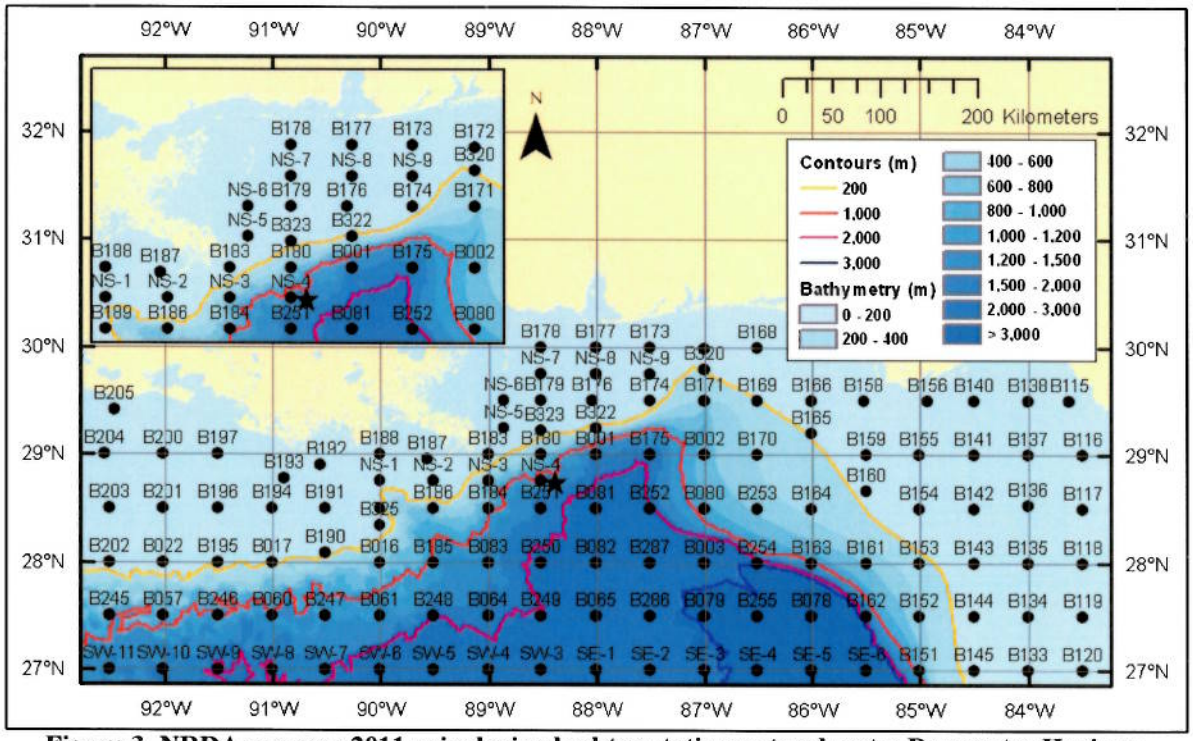

Figure 3. NRDA summer 2011 epipelagic plankton stations; star denotes Deepwater Horizon wellhead position.

Sampling Procedures

For the summer cruise, all 125 stations will be sampled sequentially. Sampling will occur around the clock, each station will be sampled once, either day or night, maintaining the exclusion +/- 30 minutes (preferably +/- 60 minutes) around sun rise/set, EXCEPT at locations where the last day sample is conducted. At these locations the boat will hold on that station while the sun sets and repeat sampling at night (thereby attaining a day/night pair) at those stations. The boat will then continue along the station path sampling once per station until the following afternoon, where it will hold station at the last location sampled before dusk and then repeat after sunset. Thus the boat will repeat sample in day/night paired stations only at the last day/first night station. This will allow 3-4 stations to be sampled each 24-hour cycle. This protocol is designed to capture changes in densities due to the diel cycle of zooplankton vertical migration.

In the upper 200m of the water column ichthyo- and zooplankton will be sampled using paired bongo nets and at the water surface using two different neuston nets (rectangular and manta). Standard SEAMAP sampling protocols will be followed at each station for the oblique bongo tow to a maximum depth of 200 m (0.333 mm mesh) and a 10 min rectangular neuston tow (0.950 mm mesh). In addition, a manta neuston net (0.950 mm mesh; Attachment 13) will be towed at the surface to aid in ichthyoplankton collections. The manta net is designed to maintain the net frame in close contact with the water surface and keep the gear away from the vessel during the tow. Data from paired neuston tows will allow inter-gear comparison of sampling efficiency. A CTD profile will be conducted to a maximum depth of 250m (the bongo tow and CTD cast will be shallower than 200m if the local water depth is <200m). For all sampling gears, detailed observations (abundance, wet weight volume, and species) of net-caught jellyfish, ctenophores, and other large items, such as *Sargassum*, will be made. Large biota and other

items will be rinsed, quantified, recorded, photographed, and discarded. These items will not be kept due to storage capacity limitations. The following gear will be deployed at every station.

Bongo Nets:
Deep Tows: Deep bongo tows (0.333 mm mesh) will be conducted to a maximum depth of 200m, towed obliquely as per standard SEAMAP sampling protocols. If the local water depth is less than 200m the nets will be deployed to a maximum of 5m above the bottom. (See also Attachment 14 for protocols to avoid bottom hazards.) The sample attained from the left bongo net will be immediately preserved in 70% ethanol and transferred approximately 24-48 hours later into fresh 70% ethanol. Samples from the right bongo will be immediately preserved in 10% buffered formalin. For detailed description of bongo net deployment protocols and sample processing see Attachment 11.

Shallow Tows: In waters >100m deep, shallow bongo tows (0.333 mm mesh) will be conducted to a variable depth coinciding with the pycnocline delineating the upper mixed layer (generally ~40m), as determined by the CTD cast. The bongo will be lowered to the depth of the pycnocline and recovered obliquely as per the protocols for the deep tows (see above). The sample attained from the left bongo net will be immediately preserved in 70% ethanol and transferred approximately 24-48 hours later into fresh 70% ethanol. Samples from the right bongo will be immediately preserved in 10% buffered formalin. For detailed description of bongo net deployment protocols and sample processing see Attachment 11.

Rectangular Neuston Net: In the top 1m of the water column ichthyo- and zooplankton will be sampled using a rectangular neuston net (0.950 mm mesh). Standard SEAMAP sampling protocols will be followed at each station – a 10 minute tow. The duration of a neuston tow may be shortened to no less than 5 minutes when high concentrations of jellyfish, ctenophores, *Sargassum*, floating weed and/or debris are present in the water, or weather requires it. Samples from the neuston net will be immediately preserved in 10% buffered formalin. For detailed description of the neuston net deployment protocols and sample processing see Attachment 12.

Manta Neuston Net: In the top 1m of the water column ichthyo- and zooplankton will be sampled using a manta neuston net (0.950 mm mesh). Each tow will be 10 minutes. The duration of a neuston tow may be shortened to no less than 5 minutes when high concentrations of jellyfish, ctenophores, *Sargassum*, floating weed and/or debris are present in the water, or weather requires it. Samples from the manta neuston net will be immediately preserved in 10% buffered formalin. For detailed description of the manta net and sample processing see Attachment 13.

Food Web and Isotope Analyses: At every third station, additional ~5-min surface tow collections will be performed using the bongos and the rectangular neuston net. Consumers (i.e. fishes, invertebrates) will be individually selected out of these surface bongo and neuston net tows and frozen. The rest of the net collections will be frozen in bulk. In addition at these stations, surface particulate organic matter (POM) will be obtained by collecting 7 liters of surface seawater and filtering over 47 mm GF/F filters (which have been pre-combusted for 1 hr at 450°C) in the wet lab on board. All samples will be frozen for possible future food web analysis (stable isotope analysis of $\delta^{13}C$ and $\delta^{15}N$) using a stable isotope mass spectrometer. Any agreement regarding analysis of the collected samples will be determined in subsequently developed, reviewed and approved cooperative work plan(s).

CTD: A Seabird CTD profiling package will be deployed to 250 m with the following sensors: dissolved oxygen, chlorophyll fluorometer, turbidity, transmissometer, and salinity, temperature, and depth information (i.e., pressure).

In general, CTD casts should be conducted while the vessel is drifting. Because the plankton tows are performed over a tow path, as opposed to at a single location, the objective is to characterize the water

properties over the general area of the tow. The start and finish locations shall be recorded for both the down- and the up-cast of the CTD. Local conditions in sea state and operational areas will dictate if maintaining position with dynamic positioning (DP) is necessary. It will be recorded whether a cast was completed while drifting or under DP.

Data Management and Trustee Oversight

All profile, acoustic, and other electronic data (including photographs) will be saved to an on-board computer, and all data shall be migrated to a dedicated hard drive. The data will be controlled and managed by the trustees under project protocols, including Chain-of-Custody tracking of the hard drive. Data is generally organized by station and all electronic data files will be filed into this structure by NOAA NRDA data manager with the assistance of the operator/data logger. The hard drive will be duplicated in full immediately following the cruise, and the duplicate hard drives will be provided to (1) the Louisiana Oil Spill Coordinator's Office (LOSCO) on behalf of the State of Louisiana, and to (2) Cardno ENTRIX on behalf of BP. The original hard drive shall be kept in a secure facility in trustee custody.

Under the direction of the Chief Scientist, a NOAA Data Manager on board each vessel will summarize sampling activities and scientific observations throughout the day and email a daily report to a designated list of recipients and NOAA NRDA ([redacted]) by midnight each day of the cruise.

By the end of the cruise, all documentation produced onboard, including COCs, field notes, sampling logs, sampling forms, photos, photo logs, ship logs, and GPS tracking shall be transferred to the NOAA NRDA Sample Intake Team following NRDA data management protocols. An identical copy of all documentation will be provided to LOSCO, on behalf of the State of Louisiana, and BP/Cardno ENTRIX at the end of the cruise.

Logistics

Vessel

Operations will be completed on the M/V *Bunny Bordelon*, Bordelon Marine, currently home ported at Bordelon Boat Yard, Houma, LA.

Personnel for M/V Bunny Bordelon

Chief Scientist
Alternate Watch Lead
2 NOAA Data Managers
4 NOAA Samplers
Cardno ENTRIX Lead
2 Cardno ENTRIX Representatives

Budgeting

The Parties acknowledge that this budget is an estimate, and that actual costs may prove to be higher due to a number of potential factors. As soon as factors are identified that may increase the estimated cost, BP will be notified and a change order describing the nature and cause for the increase cost in addition to a revised budget for BP's consideration and review.

Budget Chart #1.

Field Survey Costs	Hrs/Days/Trips	Day/Hr Rate	Total
NOAA Labor (days):			
NOAA Chief Scientist	[redacted]	[redacted]	$175,000
NOAA Alternate Watch Lead			$140,000
4 Plankton/Net handlers			$420,000
2 Data Manager			$210,000
Misc Costs Sample Handling	1	$10,000	$10,000
Travel	1	$25,000	$25,000
TOTAL			**$980,000**

Days/Trips based on 75 potential cruising days. Labor is estimated cost and hours.

Budget Chart #2.

Vessel Costs	Total
Mobilization Costs	$95,000
Vessel Costs	$3,353,316
CSA Fleet Mgmt / Shore Support	$250,000
Total Estimated Cost	**$3,698,316**

Fuel & Lube estimates included in Vessel Cost

Safety Plans

BP's full operations and safety plans are attached as appendices. A HASP binder is provided to each vessel. In addition, the NOAA incident site safety plan (which all NOAA employees and contractors must sign prior to the cruise) is attached (Attachment 4). Vessels will call into SIMOPS based on the current regulations (Attachment 5). Vessels will report in daily using the attached situation report (Attachment 6).

Attachment 2 & 2A-2E provides SOPs for the protection and conservation of marine mammals and any species listed under the Endangered Species Act as appropriate for the vessel and sampling equipment operations to be conducted on this cruise.

Laboratory

Epipelagic samples will be transferred, and held under NOAA chain of custody, to Dr. Malinda Sutor of the Department of Oceanography and Coastal Sciences of Louisiana State University where they will be stored in a secure facility for further processing. Food web samples will be transferred and held under NOAA chain of custody at Alpha Analytical (Mansfield, MA), and stored in a secure facility. Samples will be later processed in the lab of David Wells (San Diego, CA) and data distributed as described in a separate workplan (currently under development).

Sample Retention

All materials associated with the collection or analysis of samples under these protocols or pursuant to any approved work plan, except those consumed as a consequence of the applicable sampling or analytical process, must be retained unless and until approval is given for their disposal in accordance with the retention requirements set forth in paragraph 14 of Pretrial Order # 1 (issued August 10, 2010) and any other applicable Court Orders governing tangible items that are or may be issued in MDL No. 2179 IN RE: Oil Spill by the Oil Rig "DEEPWATER HORIZON" (E.D. LA 2010). Such approval to dispose must be given in writing and by a person authorized to direct such action on behalf of the state or federal agency whose employees or contractors are in possession or control of such materials.

Distribution of Laboratory Results

Each laboratory shall simultaneously deliver raw data, including all necessary metadata, generated as part of this work plan as a Laboratory Analytical Data Package (LADP) to the trustee Data Management Team (DMT), the Louisiana Oil Spill Coordinator's Office (LOSCO) on behalf of the State of Louisiana and to BP (or Cardno ENTRIX on behalf of BP). The electronic data deliverable (EDD) spreadsheet with pre-validated analytical results, which is a component of the complete LADP, will also be delivered to the secure FTP drop box maintained by the trustees' Data Management Team (DMT). Any preliminary data distributed to the DMT shall also be distributed to LOSCO and to BP (or Cardno ENTRIX on behalf of BP). Thereafter, the DMT will validate and perform quality assurance/quality control (QA/QC) procedures on the LADP consistent with the authorized Analytical Quality Assurance Plan, after which time the validated/QA/QC'd data shall be made available simultaneously to all trustees and BP (or Cardno ENTRIX on behalf of BP). Any questions raised on the validated/QA/QC results shall be handled per the procedures in the Analytical Quality Assurance Plan and the issue and results shall be distributed to all parties. In the interest of maintaining one consistent data set for use by all parties, only the validated/QA/QC'd data set released by the DMT shall be considered the consensus data set. In order to assure reliability of the consensus data and full review by the parties, no party shall publish consensus data until 7 days after such data has been made available to the parties. The LADP shall not be released by the DMT, LOSCO, BP or Cardno ENTRIX prior to validation/QA/QC absent a showing of critical operational need. Should any party show a critical operational need for data prior to validation/QA/QC, any released data will be clearly marked "preliminary/unvalidated" and will be made available equally to all trustees and to BP (or Cardno ENTRIX on behalf of BP).

Attachments

Attachment 1. Summary of SEAMAP Historical Shelf and Offshore Plankton Data
Attachment 2. Protected Spp Interaction Prevention Proc_No-impact sampling gear
Attachment 2A to E. Protected Spp - 5 annexes
Attachment 3. Summer Station Locations 2011May18
Attachment 4. NOAA-NRDA_MC_252_Site_Safety_Plan_5.13.10
Attachment 5. NRDA Offshore Vessel Reporting 071311
Attachment 6. DWH Vessel Daily SitRep
Attachment 7. NRDA_Field_Sampler_Data_Management_Protocol_10_23_2010
Attachment 8. Transfer of Personnel and Material at Sea 070510
Attachment 9. MC252 HSSE Incident Reporting Final 02 May 10 rev 1
Attachment 10. MC252 Analytical QAP V2.2
Attachment 11. Bongo Net Specifications and Deployment
Attachment 12. Neuston Net Specifications and Deployment
Attachment 13. Manta Net Specifications and Deployment
Attachment 14. Net deployment hazard avoidance protocol_2011Jul15

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Cruise Plan

Sampling Vessel: M/V Bunny Bordelon
Cruise Dates: July 18 – September 30, 2011

July 19, 2011

Approvals

Approval of this work plan is for the purposes of obtaining data for the Natural Resource Damage Assessment. Each party reserves its right to produce its own independent interpretation and analysis of any data collected pursuant to this work plan.

BP Approval	Printed Name	Signature	Date 1/30/12
Federal Trustee Approval	Printed Name	Signature	Date
Louisiana Approval	Printed Name KAROLIEN DEBUSSCHERE	Signature FOR ROLAND GUIDRY	Date 2/17/2012