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

NRDA 10-meter MOCNESS Winter 2011 Plankton Sampling Cruise Plan

Sampling Vessel: M/V *Meg Skansi*

January 24, 2011

Prepared by:
Deborah French-McCay, Eileen Graham, (ASA), and Malinda Sutor (LSU) on behalf of the Trustees
Reviewed by:
Dan Hahn, John Quinlan (NOAA)
Amanda Vincent, Steph Braden, Caroline Courville (Lousiana)
William Graeber, Jeffery Simms (Cardno ENTRIX), Mark Benfield (LSU) on behalf of BP

Proposed Cruise Dates
January 25 – April 1, 2011

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.

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.

Invertebrates and fish in the north-eastern Gulf of Mexico, which include early life history stages of fish and invertebrates, as well as smaller invertebrate holo-plankton, gelatinous zooplankton and fish of various size classes, are among those biota exposed to the released oil and spill-related chemicals. 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).

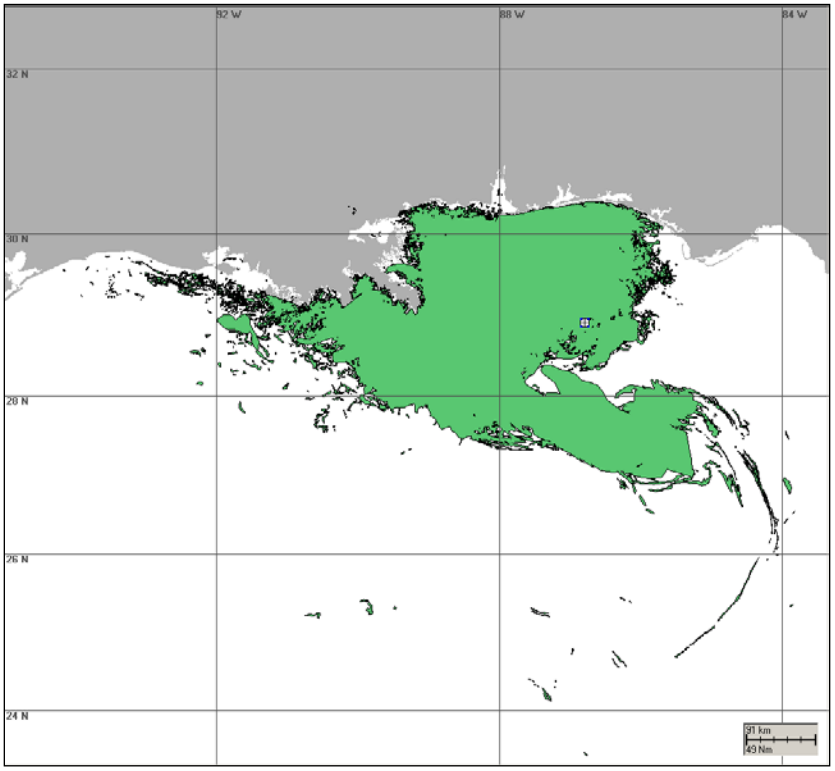

Figure 1. Cumulative potential surface floating oil extent of the Deepwater Horizon oil spill. (Figure derived from compositing April, May, June, and July 2010 radar shape files available on the NOAA ERMA website. Note that radar images with noted anomalies were not included in composite.)

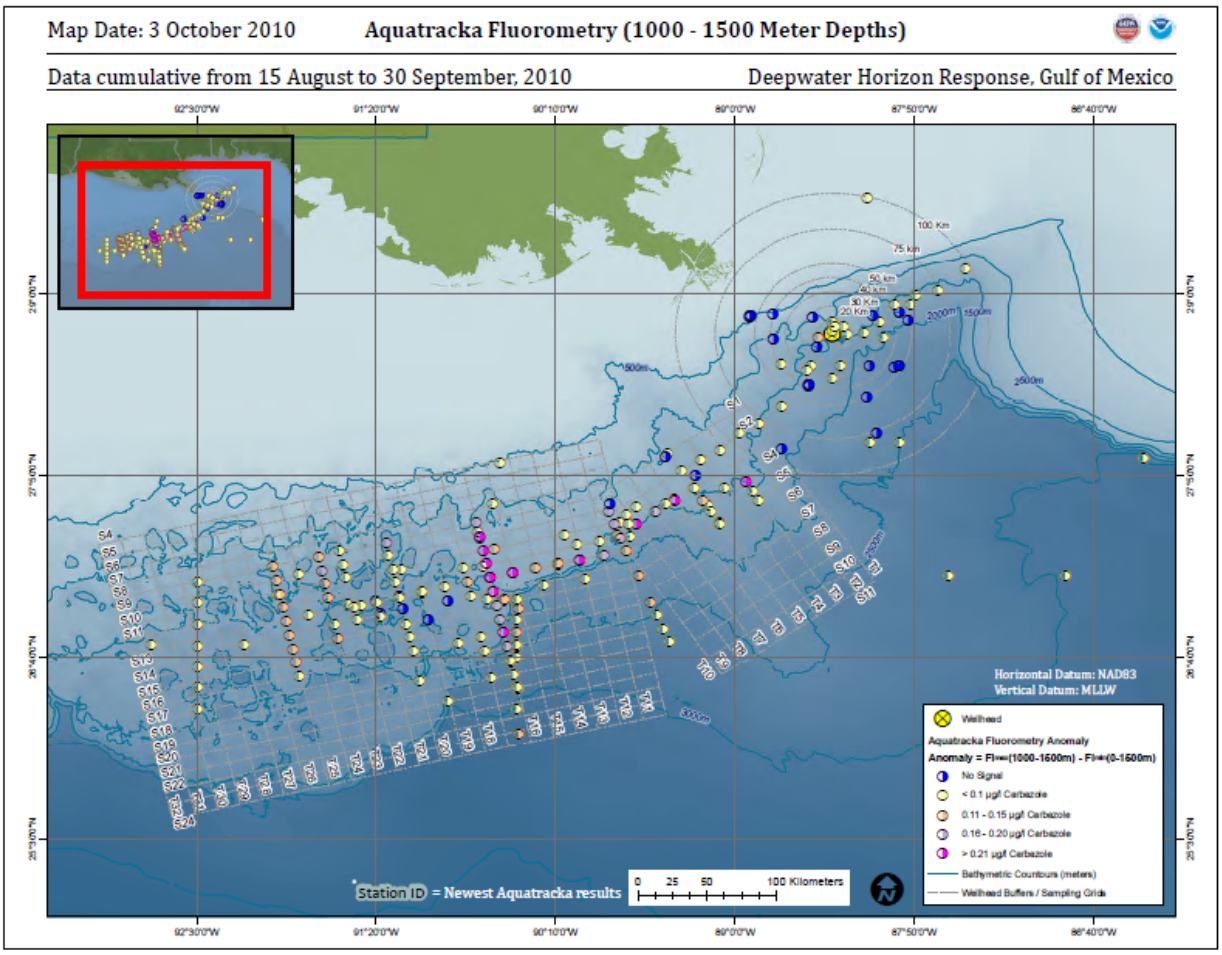

Figure 2. Cumulative summary of Aquatracka fluorescence measurements between 1000 and 1500m, 15 August to 30 September 2010.

Objectives and Approach

This plan is a series of cruises scheduled for the winter of 2011 to evaluate the distribution and densities of invertebrates (i.e., larger plankton and small nekton) and small fish (also considered small nekton) in Gulf of Mexico waters potentially affected by the Deepwater Horizon Oil Spill (DWHOS) and in surrounding areas. 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). The overall NRDA plankton sampling plan takes advantage of this historical data set and plans for continuation and extension of the NMFS Southeast Fisheries Science Center (SEFSC) SEAMAP program into deep water areas where the spill took place.

The existing data that describe large plankton and small nekton distributions in potentially affected areas in the deep-water offshore are much less extensive than data available for the shelf areas. The composition and density of these biota in the vicinity of the MC252 incident and the subsequent areas of potential impact have not been quantified. Second, vertically stratified sampling in the water column is sparse in historical data sets.

This plan, the winter 2011 *Meg Skansi* deep water plankton sampling plan, describes the sampling effort for winter 2011. The over-arching plan is to conduct sampling in each season. The duration of the program with respect to the number of years is to be determined. The same sampling design will be as

was described and agreed upon for the winter 2011 1-m^2 Multiple Opening/Closing Net and Environmental Sensing System (MOCNESS) plan, the difference being the size of the gear used. The larger 10-m^2 MOCNESS captures larger and more motile animals than may be captured by the 1-m^2 MOCNESS, because the larger nets make avoidance more difficult, and more water is sampled than for the smaller net system. Sampling and ship-board processing protocols have been developed for offshore stations for the entire water column. The primary objective is to collect depth discrete samples at various intervals throughout the entire water column using a 10-m^2 MOCNESS. The occurrence, abundance, biomass, vertical distribution, and daily vertical migration of large plankton and small nekton of both surface and deep water species/life stages of the Gulf of Mexico will be assessed. Stations correspond to locations sampled during the winter 2011 1-m^2 MOCNESS cruises (which correspond to those sampled on the 2010 SEAMAP Fall Plankton survey cruise on the R/V *Gordon Gunter* and the 2011 SEAMAP Winter Plankton survey cruise on the R/V *Oregon II*).

Methodology

Sampling Stations

Due to the locations where oil exposure may have occurred (Figures 1 and 2 show some of the areas where contaminants have been observed), there is a need to sample additional stations beyond the shelf region off the coast of Louisiana, Mississippi, Alabama, and Florida, all of which are routinely sampled by the SEAMAP program (Attachment 9). The standard SEAMAP plankton sampling grid extends from the Texas shelf all the way to the Florida west coast shelf. The grid runs from the coast out to the 200m bathymetric contour in the shelf waters of the gulf. Grid cells are 30 x 30 NM, with sampling stations located at the mid-point of each grid cell. For more detail on SEAMAP protocols, the annual SEAMAP environmental and biological atlas reports are found at: http://www.gsmfc.org/default.php?p=sm_ov.htm#:content@8:links@4.

In plans implemented in the fall of 2010 and in the 1-m^2 MOCNESS plan, additional stations were added to the SEAMAP grid to help fill the data gap for sampling surface waters (>200m) in the offshore areas near the spill (Figure 3). The extent of the offshore sampling grid is based on knowledge that currents and animal movements disperse water column biota widely in the northeastern Gulf of Mexico, such that a broad area needs to be sampled to evaluate areas potentially affected. In this work plan, the 46 deep water stations (Figure 3, Table 1) targeted for deep 1-m^2 MOCNESS sampling will be sampled using the 10-m^2 MOCNESS. Given the vagaries of weather at this time of year, the priority stations to be sampled will be those sampled using the 1-m^2 MOCNESS in the fall of 2010; however, the objective is to sample all stations listed. This cruise will depart 25 January 2011 and return when all stations have been sampled (both day and night) or by 1 April 2011, whichever is sooner. Functionally, the cruise will be divided into legs as dictated by the availability of chief scientists, other personnel, supply needs, and weather events.

This particular effort is being developed as a cooperative program, but is ultimately Trustee-lead as required by OPA regulations. As such, these cruises will be lead at sea by a Trustee-appointed Chief Scientist who serves as a Trustee-representative. The Chief Scientist will serve in the traditional capacity of Chief Scientists aboard academic and NOAA cruises. 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. They will discuss operational issues with the CSA lead, as appropriate. The Chief Scientist will be responsible for notifying the designated NOAA lead, ENTRIX lead and CSA lead regarding schedule changes, so that each lead may notify staff and adjust their respective staff mobilization schedules, as needed.

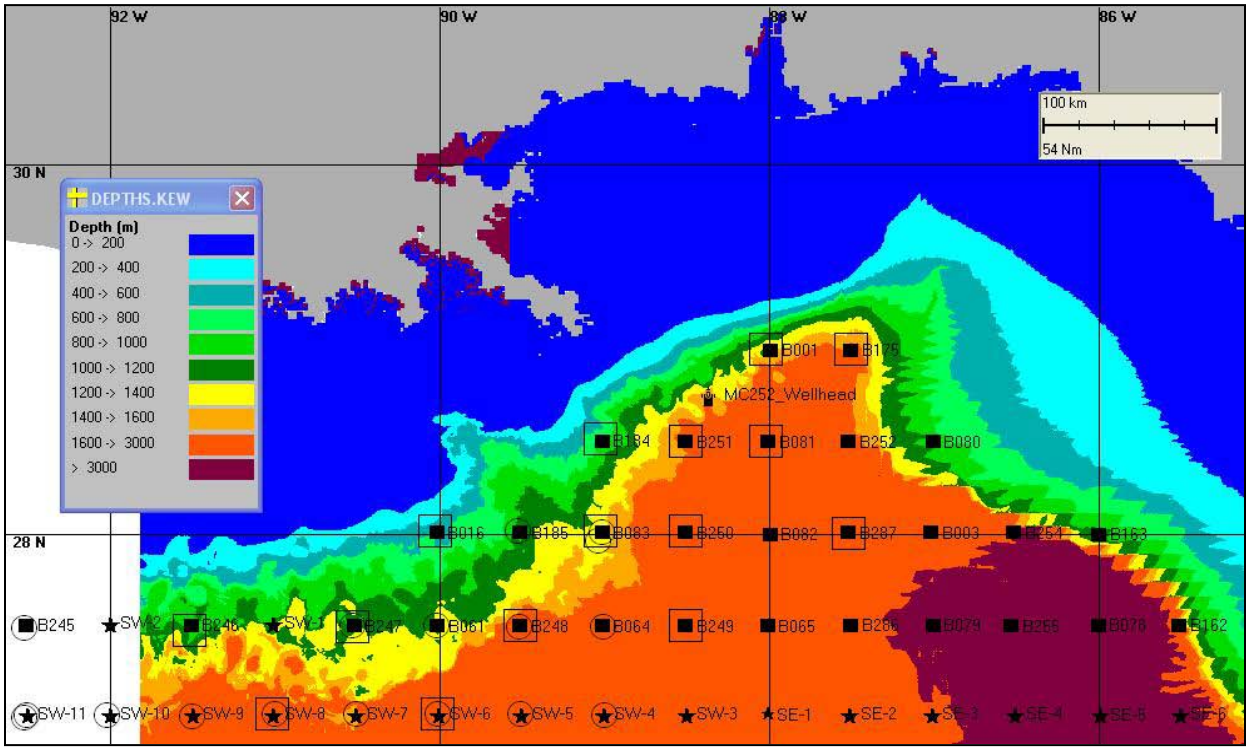

Figure 3. Deepwater stations to be sampled with 10-m^2 MOCNESS during Meg Skansi Winter 2011 10-m^2 MOCNESS Cruise (all symbols). Solid square icons represent stations that were part of the Fall SEAMAP sampling regime; starred icons represent stations added to the SEAMAP grid for deepwater 1-m MOCNESS sampling. Circle outlines are stations sampled on the *Nick Skansi* in Fall of 2010 and square outlines are stations sampled on the *Walton Smith* in Fall of 2010.

Table 1. Coordinates of deepwater stations to be sampled during *Meg Skansi* Winter 2011 Cruise

Station Number	Longitude	Latitude	Station Number	Longitude	Latitude
B001	[redacted]	[redacted]	B251	[redacted]	[redacted]
B003	[redacted]	[redacted]	B252	[redacted]	[redacted]
B016	[redacted]	[redacted]	B254	[redacted]	[redacted]
B061	[redacted]	[redacted]	B255	[redacted]	[redacted]
B064	[redacted]	[redacted]	B286	[redacted]	[redacted]
B065	[redacted]	[redacted]	B287	[redacted]	[redacted]
B078	[redacted]	[redacted]	SW-1	[redacted]	[redacted]
B079	[redacted]	[redacted]	SW-2	[redacted]	[redacted]
B080	[redacted]	[redacted]	SW-3	[redacted]	[redacted]
B081	[redacted]	[redacted]	SW-4	[redacted]	[redacted]
B082	[redacted]	[redacted]	SW-5	[redacted]	[redacted]
B083	[redacted]	[redacted]	SW-6	[redacted]	[redacted]
B162	[redacted]	[redacted]	SW-7	[redacted]	[redacted]
B163	[redacted]	[redacted]	SW-8	[redacted]	[redacted]
B175	[redacted]	[redacted]	SW-9	[redacted]	[redacted]
B184	[redacted]	[redacted]	SW-10	[redacted]	[redacted]
B185	[redacted]	[redacted]	SW-11	[redacted]	[redacted]
B245	[redacted]	[redacted]	SE-1	[redacted]	[redacted]
B246	[redacted]	[redacted]	SE-2	[redacted]	[redacted]
B247	[redacted]	[redacted]	SE-3	[redacted]	[redacted]
B248	[redacted]	[redacted]	SE-4	[redacted]	[redacted]
B249	[redacted]	[redacted]	SE-5	[redacted]	[redacted]
B250	[redacted]	[redacted]	SE-6	[redacted]	[redacted]

Sampling Procedures

MOCNESS: Vertical distribution of plankton in the entire water column (with a safety margin near bottom) will be measured by sampling in discrete depth intervals at the offshore stations in Figure 3 using a 10-m^2 Multiple Opening and Closing Net and Environmental Sensing System (MOCNESS) (3 mm mesh). The MOCNESS is an instrumented net system that is capable of taking discrete samples over specific depth strata (Figure 4). The instrument package on the MOCNESS can record data on water column physical properties as well as chlorophyll fluorescence. Details of the sampling protocol are in Attachment 10.

Table 2 contains the depth bins sampled by the 1-m^2 MOCNESS in the winter 2011 plan, as well as in the fall of 2010. The 1-m^2 MOCNESS has (in 2010) and will (2011) be towed obliquely through the water column from a maximum depth of 1500 m, as that was the approximate limits of the winch cable available for that gear in Fall 2010. The 1500m depth is also below the depth range where most of the deepwater measurements have indicated oil contamination from the spill occurred. For consistency, the 10-m^2 MOCNESS will be towed obliquely through the water column from a maximum depth of 1500 m, or that determined to be comfortably off the seabed by the Chief Scientist. The first net (Net 0) will be open all the way down to the deepest depth sampled. Upon commencing the oblique tow back to the surface, the second net will be opened and cover the Net 1 depth range in Table 3. Additional nets will be opened and closed at depth intervals as noted in Table 3 until the epipelagic zone lower limit (at 200m). The epipelagic zone will be sampled with Net 5 as the final depth interval 200-0m (Table 3). While the bottom depth at the different stations will vary (if the water depth is less than 1500m), using standard depth bins for the other nets at all stations allows us to compare the data between stations. The depth bins

are spaced to resolve the deep water column with the limitation of six nets. The upper depth bin of 200-0m was chosen as it is the same depth strata sampled by nets in the SEAMAP program and this will allow us to directly compare our data to the SEAMAP data.

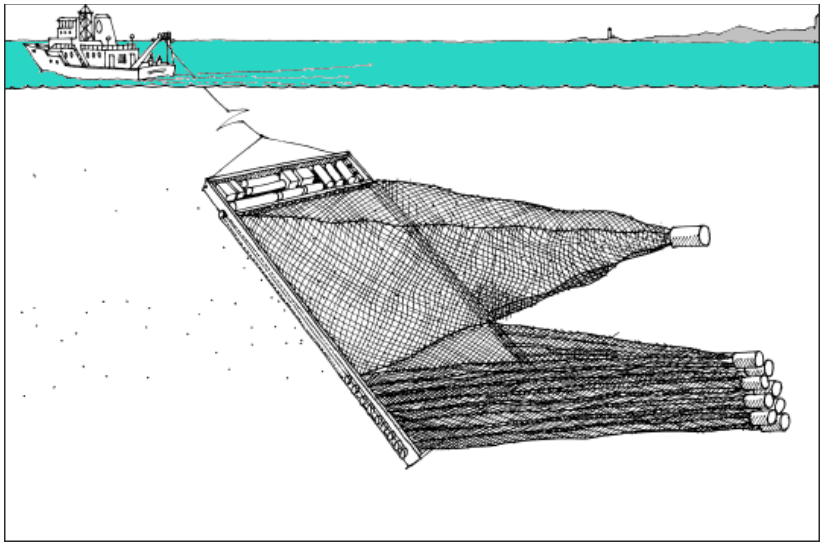

Figure 4. Schematic showing general MOCNESS deployment.

Table 2. 1-m^2 MOCNESS depth bins.

Net Number	Depth Bin (m)
Net 0	0-1500
Net 1	1500-1200
Net 2	1200-1000
Net 3	1000-800
Net 4	800-600
Net 5	600-400
Net 6	400-200
Net 7	200-25
Net 8	25-0

Table 3. 10-m^2 MOCNESS depth bins.

Net Number	Depth Bin (m)
Net 0	0-1500
Net 1	1500-1200
Net 2	1200-1000
Net 3	1000-600
Net 4	600-200
Net 5	200-0

The MOCNESS will be deployed twice at each station (1 day tow, 1 night tow). Sampling will occur 24-hours a day. At each station, a tow of 4-6 hours duration will take place during the day and a tow of 4-6 hours duration will take place at night. These will be timed to best capture the differences in diel distribution patterns. The changes in densities due to the diel cycle of zooplankton vertical migration will be evident in these data.

All samples will be preserved immediately after recovering the nets per the description in Attachment 10. At the end of each leg, samples will be transported under NOAA NRDA Chain of Custody to Malinda Sutor's laboratory at Louisiana State University (LSU) or another NOAA NRDA controlled location at her direction. Samples will be processed in the lab and data distributed as described in a separate workplan (currently under development).

At-sea transfer of samples is not anticipated as no samples with designated hold times are planned. If an at-sea transfer of samples becomes necessary, the standard protocol to maintain the appropriate chain of custody will be employed (see Cooperative December Cruise Plan for a description).

CTD: A Seabird CTD profiling package (which can be deployed to a depth of 6000 meters) will be deployed to full ocean depth with the following sensors: dissolved oxygen, chlorophyll fluorometer, Aquatracka (Attachment 13), turbidity, transmissometer, and salinity, temperature, and depth information.

Acoustics: The *Meg Skansi* will collect acoustic data using a SIMRAD EK60 scientific echosounder and 38 kHz and 200 kHz transducers or a Sonardyne Model 7707 19-36 kHz system (depending on the water depth). The purpose of the acoustic surveys is two-fold: (1) collection of detailed bathymetry to understand seafloor morphology, and (2) potential identification of backscatter anomalies in the water column that may indicate biota. For a further description of acoustic data collection, please see Attachments 11.

Data Management and Trustee Oversight: All profile, acoustic, and other electronic data 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. The hard drive will be duplicated in full immediately following the cruise, and the duplicate hard drive will be provided to 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.

In addition, Cardno ENTRIX will use an internal data management system to store, manage and process data from all study elements. This system will accommodate all chemistry and quality assurance data in formats compatible with BP's centralized database. A data management plan will be prepared to document the systems and procedures that will be used to ensure that data quality and data integrity are maintained throughout data management processes (see MC252 Analytical QAP and Quality Assurance Guidelines appendices).

Logistics

Vessel:

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

Personnel for M/V *Meg Skansi*:
This cruise will require 24 hour operations. The M/V Meg Skansi has 24 berths which consist of eight 2-person and two 4-person rooms. Seven spaces are allotted for boat crew. Operations (CSA) has requested 8 slots, 4 people per shift. On each cruise leg, the trustees will have one Chief Scientist plus 5 science staff, and BP will have a senior scientist and 2 science staff.

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 provided describing the nature and cause for the increase cost in addition to a revised budget for BP's consideration and review. The field survey costs, miscellaneous costs, and travel costs indicated in Budget Chart # 1 below shall be reimbursed by BP upon receipt of written invoices submitted by the Trustees. The Vessel Costs indicated in Budget Chart # 2 shall be paid directly by BP.

Budget Chart #1.

Field Survey Costs	Hrs/Days/Trips	Day/Hr Rate	Total
NOAA Labor (days):			
NOAA Chief Scientist	[redacted]	[redacted]	$175,000
4 Plankton/Net handlers	[redacted]	[redacted]	$420,000
1 Data Manager	[redacted]	[redacted]	$105,000
Misc Costs Sample Handling	1	$10,000	$10,000
Travel	1	$25,000	$25,000
TOTAL			**$735,000**

Days/Trips based on 70 potential cruising days. Labor is estimated cost and hours.

Budget Chart #2.

Vessel Costs	Total
Mobilization Costs	$362,250
Vessel Costs	$3,127,591
CSA Fleet Mgmt / Shore Support	$210,000
Total Estimated Cost	**$3,699,841**

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 1). Vessels will call into SIMOPS based on the current regulations (Attachment 5). Vessels will report in daily using the attached situation report (Attachment 6).

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 Quality Assurance Project 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 Quality Assurance Project 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. NOAA-NRDA_MC_252_Site_Safety_Plan_5.13.10
Attachment 2. MC252 HSSE Incident Reporting Final 02 May 10 rev 1
Attachment 3. CSA-Davis HSE Plan Rev 005_Final
Attachment 4. Transfer of Personnel and Material at Sea 070510
Attachment 5. NRDA SIMOPS Procedures 111710
Attachment 6. DWH Vessel Daily SitRep
Attachment 7. MC252 Analytical QAP V2.1
Attachment 8. NRDA_Field_Sampler_Data_Management_Protocol_10_23_2010
Attachment 9. Historical Plankton Data_2010Aug17
Attachment 10. Mocness_Deployment_Protocol
Attachment 11. Acoustic Data Collection EK60
Attachment 12. Chelsea Aquatracka Fluorometer

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

NRDA 10-meter MOCNESS Winter 2011 Plankton Sampling Cruise Plan

Sampling Vessel: M/V *Meg Skansi*

Cruise Dates: 25 January – 1 April 2011

Plan Date: January 23, 2010

Approvals

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

BP Approval — Robin Bullock (Printed Name) — Robin Bullock (Signature) — 1/26/2011 (Date)

Federal Trustee Approval — Jessica White (Printed Name) — Jessica White (Signature) — 1/25/2011 (Date)

Louisiana Approval — KAROLIEN DEBOSSCHER (Printed Name) — FOR ROLAND GOLDEN (Signature) — 2/23/11 (Date)