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

NRDA 10-meter MOCNESS Spring 2011 Plankton Sampling Cruise Plan

Sampling Vessel: M/V *Meg Skansi*

April 16, 2011

Prepared by:
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on behalf of the Trustees
Reviewed by:
NOAA: Branden Blum, Dan Hahn, John Quinlan
Louisiana: Amanda Vincent (LOSCO)
BP: William Graeber, Jeffery Simms, & Amy Piko (Cardno ENTRIX) on behalf of BP

Proposed Cruise Dates
April 18 – June 30, 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).

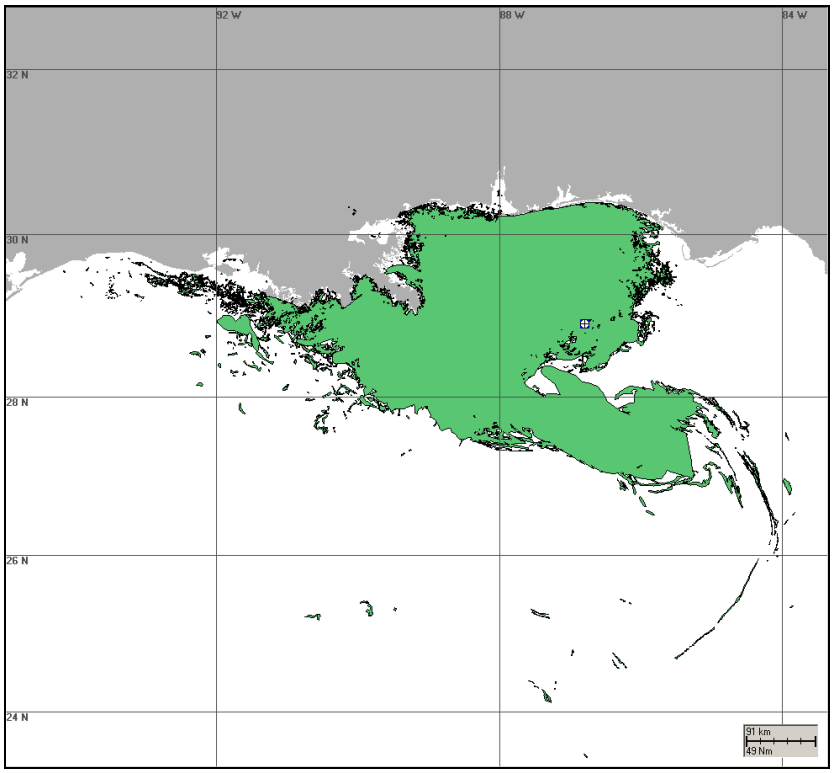

Figure 1. Cumulative potential surface floating oil extent of the Deepwater Horizon oil spill. (Figure derived from compositing April, May, June, and July 2010 radar shape files available on the NOAA ERMA website. Note that radar images with noted anomalies were not included in composite.)

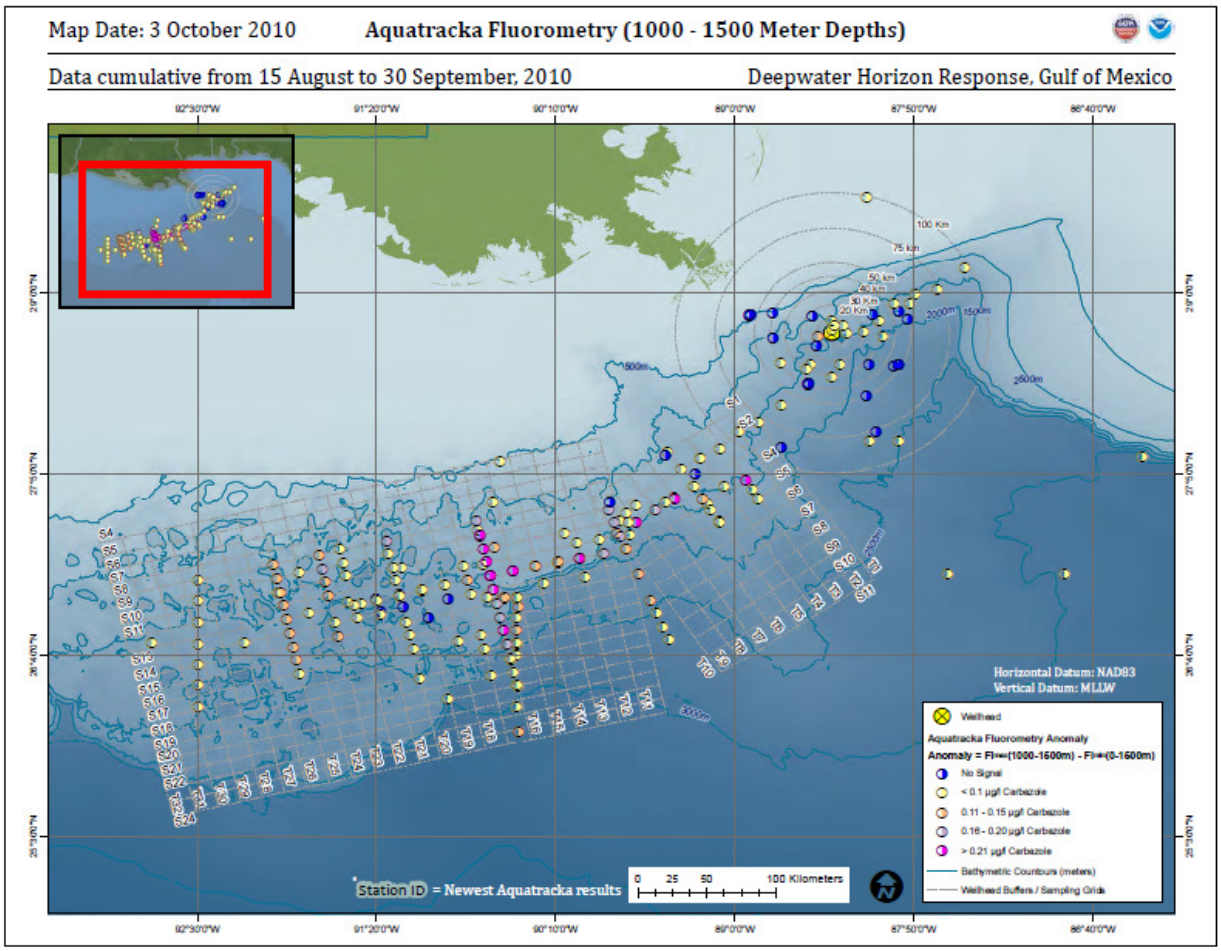

Figure 2. Cumulative summary of Aquatracka fluorescence measurements between 1000 and 1500m, 15 August to 30 September 2010.

Objectives and Approach

This plan is a series of cruises scheduled for the spring 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 200 m 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 prior to this spill-related sampling program. Second, vertically stratified sampling in the water column is sparse in historical data sets. The larger 10-m^2 Multiple Opening/Closing Net and Environmental Sensing System (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 because more water is sampled.

This plan, the spring 2011 *Meg Skansi* deep water 10-m^2 MOCNESS sampling plan, describes the sampling effort for spring 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 sampling design will be the same as was described and agreed upon for the winter 2011 10-m^2 MOCNESS plan. 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 10-m^2 MOCNESS cruises (which correspond to those sampled on the 2010-2011 SEAMAP Plankton survey cruises).

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 16 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

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, including spring sampling locations 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 200 m 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@12:links@13.

In biological sampling plans implemented in the fall of 2010 and winter 2011, additional stations were added to the SEAMAP grid to help fill the data gap for sampling 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. In this work plan, the 46 deep water stations (Figure 3, Table 1) targeted for winter 2011 10-m^2 MOCNESS sampling will be sampled. The priority stations to be sampled will be those sampled during the winter 2011 survey; however, the objective is to sample all stations listed. This cruise will depart 14 April 2011 and return when all stations have been sampled (both day and night) or by 30 June 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-led 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.

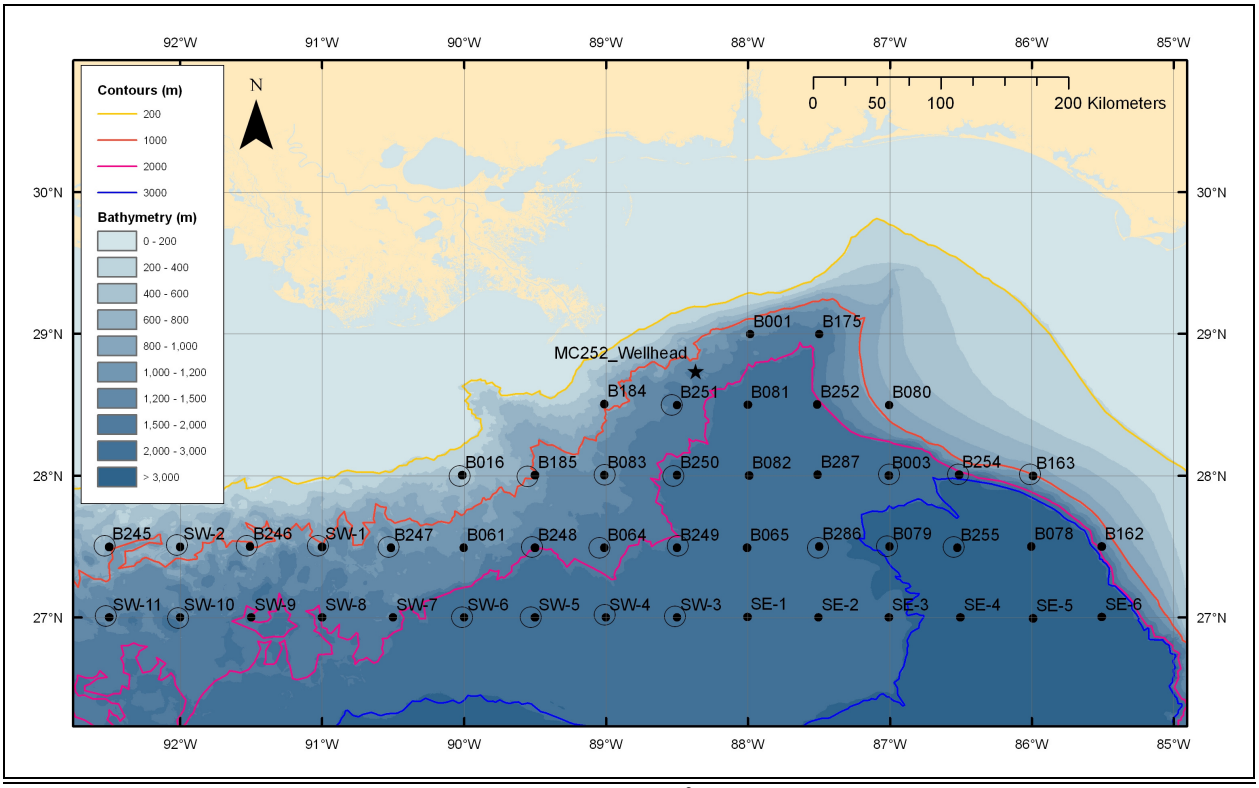

Figure 3. Deepwater stations to be sampled with 10-m^2 MOCNESS during Meg Skansi Spring 2011 10-m^2 MOCNESS Cruise (solid black circles). Open circles depict stations sampled by the 10-m^2 MOCNESS during the first 4 legs of the Winter 2011 survey.

Table 1. Coordinates of deepwater stations to be sampled during *Meg Skansi* Spring 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]

Station Number	Longitude	Latitude		Station Number	Longitude	Latitude
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 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. The instrument package on the MOCNESS can record data on water column physical properties as well as chlorophyll fluorescence. Details of the deployment protocol are in Attachment 10. Also refer to the revised MOC 1 & MOC 10 Deep tow protocol for details on the operational measures that will be taken to avoid and minimize risks of gear groundings (Attachment 15).

The MOCNESS will be deployed twice at each station (1 day tow, 1 night tow), requiring 24-hour operations. Each tow will be 4-6 hours in duration and will be timed to best capture the differences in diel distribution patterns. The 10-m^2 MOCNESS will be towed obliquely through the water column. 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 2. Additional nets will be opened and closed at depth intervals as noted in Table 2 until the epipelagic zone lower limit (at 200 m). The epipelagic zone will be sampled with Net 5 as the final depth interval 200-0 m (Table 2). While the bottom depth at the different stations will vary, 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 200-0 m 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.

Table 2. 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

All samples will be preserved immediately after recovering the nets per the description in Attachment 11. 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). The Sutor lab will be responsible for splitting the samples, retaining the plankton component, and sending the nekton component under Chain of Custody to Tracey Sutton's laboratory at the Virginia Institute of Marine Science (VIMS). All samples at both laboratories will be stored in a secure facility. Samples will be processed in these labs 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 NOAA 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 m) will be deployed with the following sensors: dissolved oxygen, chlorophyll fluorometer, Aquatracka (Attachment 12), turbidity, transmissometer, and salinity, temperature, and depth information.

CTD casts will be performed at each station to the full water column depth for stations where the maximum net sampling depth is within 100 m of the sea floor (i.e., at stations with water depths < 1600 m). At stations with depths between 1600 and 2000 m, CTD casts will be performed to at least 1500 m and beyond to the greatest depth that is operationally appropriate. At stations with depths greater than 2000 m, CTD casts will be performed to at least 1500 m. The total depth of CTD casts may be decreased if there are time constraints that would potentially limit MOCNESS deployment at scheduled times.

In general, CTD casts should be conducted while the vessel is drifting. Because the MOCNESS 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 should be recorded whether a cast was completed while drifting or under DP.

Acoustics: The *Meg Skansi* will collect acoustic data using a SIMRAD EK60 scientific echosounder and 18, 38 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 including a deep water collection SOP, please see Attachment 13.

The 18 kHz transducer is an additional piece of equipment for this cruise. Its addition was deliberated between NOAA, BP and Cardno ENTRIX on the Vessel Coordination Committee calls in January and February. The justification and changes to the budget can be found in Attachment 14.

Positioning Data: The *Meg Skansi* is outfitted with Hypack navigation software. This software logs the cruise track for the entirety of the cruise and can mark specific locations (targets) when identified by the user. CSA staffs a navigation position and that person will be responsible for monitoring the ship track and taking targets. The data output format of the Hypack software varies depending on the type of data (i.e. ship track, target) and is a function of the way the software is coded. The official record of this data include the ship track, station location and event locations, all of which are acquired by the NOAA NRDA data manager as part of the onboard ship data catalogue. Location data recorded in individual log books are considered secondary sources and are only to be used when the primary source has been lost or otherwise compromised.

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 to BP/Cardno ENTRIX at the end of the cruise.

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 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	70	$2,500	$175,000
4 Plankton/Net handlers	70 x 4	$1,500	$420,000
1 Data Manager	70	$1,500	$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	$420,000
Vessel Costs	$3,557,504
CSA Fleet Mgmt / Shore Support	$420,000
Total Estimated Cost	**$4,397,504**

Fuel & Lube estimates included in Vessel Cost

Safety Plans

BP's full operations and safety plans are attached as appendices. A revised MOC 1 & MOC 10 Deep tow protocol to avoid and minimize risks of gear groundings is incorporated into this plan (Attachment 15). 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).

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. 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 040711
Attachment 6. DWH Vessel Daily SitRep
Attachment 7. MC252 Analytical QAP V2.2
Attachment 8. NRDA_Field_Sampler_Data_Management_Protocol_10_23_2010
Attachment 9. Historical Plankton Data_2010Aug17
Attachment 10. MOC10 Deployment Protocol
Attachment 11. MOC10 Sample Handling Preservation
Attachment 12. Chelsea Aquatracka Fluorometer
Attachment 13. Acoustic Data Collection EK60
Attachment 14. EK60 – 18 kHz Justification
Attachment 15. MOC 1 & MOC 10 Deep tow protocol
Attachment 16. Protected Spp Interaction Prevention Proc_No-impact sampling gear
Attachment 16A to E. Protected Spp - 5 annexes

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Water Column Technical Working Group

NRDA 10-meter MOCNESS Spring 2011 Plankton Sampling Cruise Plan

Sampling Vessel: M/V *Meg Skansi*

Cruise Dates: 14 April – 30 June 2011

Plan Date: April 16, 2011

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) _____ (Signature) 4-25-11 (Date)

Federal Trustee Approval Lisa DiPinto (Printed Name) _____ (Signature) 4/22/11 (Date)

Louisiana Approval KATHLEEN DOBUSCHECK (Printed Name) _____ (Signature) FOR KEITH GADDY 5/12/11 (Date)