Deepwater Horizon Oil Spill (DWHOS)

NRDA Plankton Sampling Plan & Fall 2010 Cruise Plan

Walton Smith 3

Water Column Technical Working Group

November 15, 2010

Prepared by: Deborah French-McCay & Melanie Schroeder (ASA) and Malinda Sutor (LSU)

Proposed Cruise Dates

R/V *Walton Smith* – September 26-October 3, 2010

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 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 the water column, passing contaminated water over respiratory structures, and ingesting water and oil droplets 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, which indicates areas of surface waters potentially affected. Figure 2 shows a modeled distribution of subsurface oil for a 30,000 bbl/day release from the well from 3 June to 15 July, sampled on 2 August. Currents used for the simulation are based on the real-time data obtained from Acoustic Doppler Current Profilers (ADCPs) in the area. This simulation result indicates the southwestward transport of the oil and locations where plankton may have been exposed.

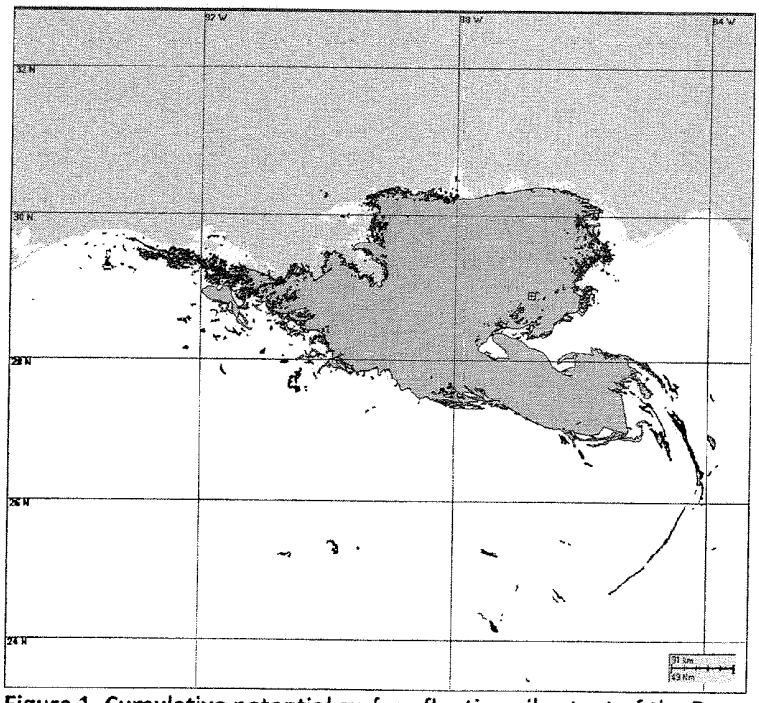

Figure 1. Cumulative potential surface floating oil extent of the Deepwater Horizon oil spill. (Figure derived from compositing April, May, June, and July 2010 radar shape files available on the NOAA ERMA website. Note that radar images with noted anomalies were not included in composite.)

Summary of Historical Shelf and Offshore Plankton Data

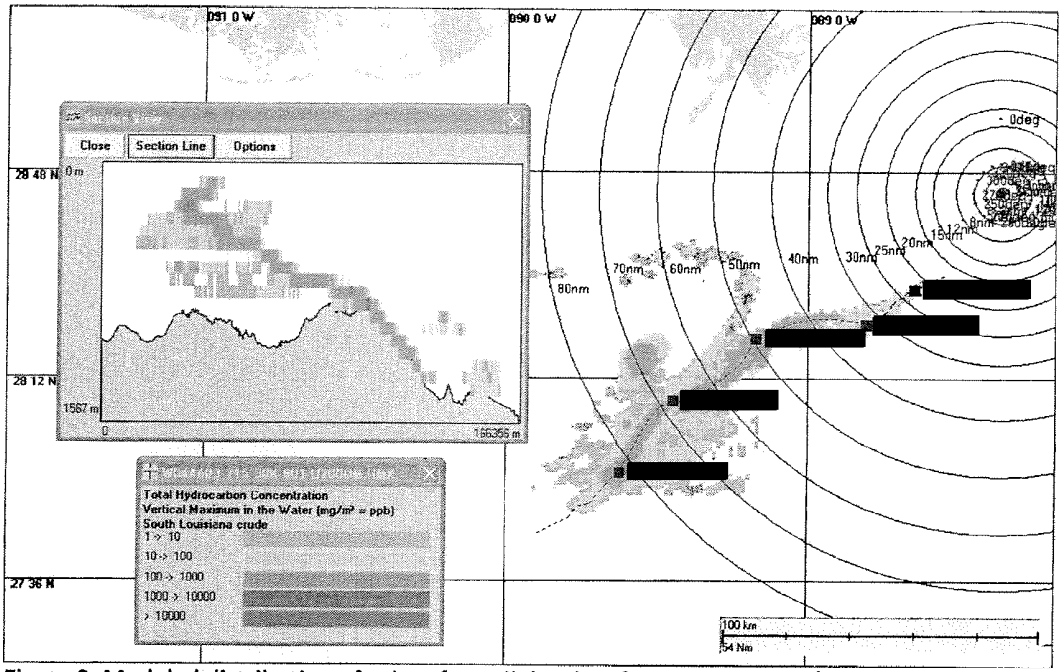

Figure 2. Modeled distribution of subsurface oil droplets from a 30,000 bbl/day release from the well from 3 June to 15 July, model output on 2 August.

Objectives and Approach: Plankton Sampling Plan

This plan is part of a series of cruises to be conducted 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. 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. In order to maximize the use of the existing data, additional sampling will be completed to determine the background state of plankton in the Gulf of Mexico. This can be completed outside the area of impact and be compared to the 25-year dataset to generate an estimate of pre-spill densities. Once the areas and water depth ranges exposed to DWHOS-related releases are delineated (by water sampling combined with fate and exposure modeling), we will identify areas suitably-representative of baseline conditions but sampled after the spill began. Baseline data (both historical and newly-acquired) will be used as injury model inputs, whereas the plankton conditions and distributions in the exposed areas/volumes will be examined for evidence of impact, as possible given the constraints of feasible sampling efforts in the extensive and naturally variable ocean volume potentially affected.

Regular SEAMAP plankton sampling was conducted this year as well as additional sampling during May (Figures 9-10 in Attachment 1), August, and September (R/V *Gordon Gunter*) in conjunction with other sampling efforts for the MC252 incident site. Additionally, as part of other NRDA sampling plans, other sampling methods (holographic camera, particle profilers) are being used to document the plankton in

close proximity to the MC252 incident site where the presence of oil precludes the use of small mesh nets. The particle profilers are also being used in areas further from the well to document distributions and densities of plankton. Comparative studies between these plankton imaging systems and traditional net-based sampling techniques have been carried out by various investigators (i.e. Broughton and Lough, 2006). These studies have shown the advantages and limitations of imaging systems. For example fragile organisms and particles such as small gelatinous organisms and marine snow are easily identified and quantified using imaging systems, where as these delicate groups are destroyed or damaged beyond recognition in net samples. Using both sampling approaches will produce an inclusive time series data set for this incident.

The existing data that describe plankton distributions in potentially affected areas in the deep-water offshore are less extensive than data available for the shelf areas. First, the composition and density of plankton in the vicinity of the MC252 incident and the subsequent areas of impact have not been quantified in detail, especially in the deep-water areas surrounding the release site. Second, vertically stratified sampling in the upper water column is sparse. The R/V *Walton Smith* 3 sampling plan herein addresses in part these data needs, with sampling in the fall of 2010. Other data gaps include the underrepresentation of soft bodied organisms in net-based surveys and a general paucity of vertically stratified sampling in the upper water column. These needs will be addressed elsewhere.

Subsequent sampling in other seasons will likely be needed, particularly in spring and summer, to provide additional quantitative information and to document the plankton community in subsequent time periods in order to evaluate degree and rate of recovery over longer time periods. The overall plan is to perform sampling in each of the four seasons over the next several years (extent of the program to be determined). Because plankton are transported over wide areas, and populations are connected across the northern Gulf of Mexico, sampling plans need to be broad in geographic scope.

Herein, the fall 2010 *Walton Smith3* deep water plankton sampling plan is described. The same overall sampling approach will be followed in subsequent seasons. Sampling and analysis protocols have been developed for offshore stations for the entire water column. The primary objective is to collect depth discrete plankton samples at various intervals throughout the entire water column using a Multiple Opening/Closing Net and Environmental Sensing System (MOCNESS). Stations correspond to locations sampled during the 2010 SEAMAP Fall Plankton survey cruise on the R/V *Gordon Gunter*. The occurrence, abundance, biomass, vertical distribution, and daily vertical migration of the early life stages of fall spawning and deep water ichthyo- and zooplankton species of the Gulf of Mexico will be assessed.

In other efforts, water sampling has and will document in part concentrations of dissolved and particulate oil, as well as droplet size distributions. These sampling plans are described in the Jack Fitz 1 to 3, American Diver 1, Hos Davis 1 to 3, and subsequent water sampling cruise plans.

Methodology

Cruise Plan and Sampling Stations

The R/V *Walton Smith* will depart Morgan City, LA on September 26, 2010 to primarily conduct deep MOCNESS sampling at offshore stations. The 7-day cruise is scheduled to come back into port on October 3, 2010. Other sampling activities are planned in conjunction with the MOCNESS including vertical profiles of water column properties (Conductivity, Temperature, Depth or CDT casts),

fluorometry profiles with the Chelsea Aquatracka, and surface plankton sampling using the shipboard flow-through system and FlowCam. Time permitting an acoustic array may also be deployed in casts to assess the horizontal and vertical distribution patterns of plankton.

In this work plan, a subset of the additional deepwater stations added to the 2010 fall SEAMAP survey are targeted for deep MOCNESS sampling. Due to the location of the oil spill (Figure 1), there was a need to sample additional stations beyond the shelf region off the coast of Louisiana, Mississippi, Alabama, and Florida during the fall *Gordon Gunter* SEAMAP cruise (August 24-September 30, 2010)(Figure 3). These additional 31 stations fill the data gap for sampling surface waters (>200M) in the offshore areas near the spill. The standard SEAMAP plankton sampling grid extends from the Texas shelf all the way 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. The position of the additional stations was determined by extending the standard 30NM fall SEAMAP sampling grid into the offshore vicinity of the spill site.
For more detail on SEAMAP protocols the annual SEAMAP environmental and biological atlas reports found at:
http://www.gsmfc.org/default.php?p=sm_ov.htm#:content@8:links@4.

At these additional stations during the *Gunter* cruise, the same sampling SEAMAP protocols and gear types were deployed (neuston net and bongo tow in the top 200m) as well as use of a 1 m Multiple Opening/Closing Net and Environmental Sensing System (MOCNESS) in the top 130m.

For this cruise a subset of the deepwater stations sampled with the MOCNESS (top 130m) by the *Gordon Gunter* will be sampled by deep towing (1500m) of the MOCNESS aboard the *Walton Smith*. *Gordon Gunter* sampling stations in <400m of water were not included in the set considered for deep towing. Six deeper stations are targeted for the *Walton Smith* 3 cruise (Figure 4, Table 1), whereas other cruises (*Walton Smith* 1, as well as cruises planned by ENTRIX) will address as many of the other stations as feasible. The subset of stations for the *Walton Smith* 3 cruise was selected because they are located in areas close to the spill site, in areas where subsurface oil has been observed, as well as east of the majority of the subsurface contamination. Shallow MOCNESS tows were conducted by the *Gunter* at all of the targeted stations for *Walton Smith* except B246 and B247. (The *Gunter* sampled approximately alternate stations with MOCNESS to 130m. Please see the *Gordon Gunter* sampling plan for further details.) For deep tows, we added the B246 and B247 stations because of the exposure to the deepwater oil plume in that vicinity, which has been observed in water sampling cruises.

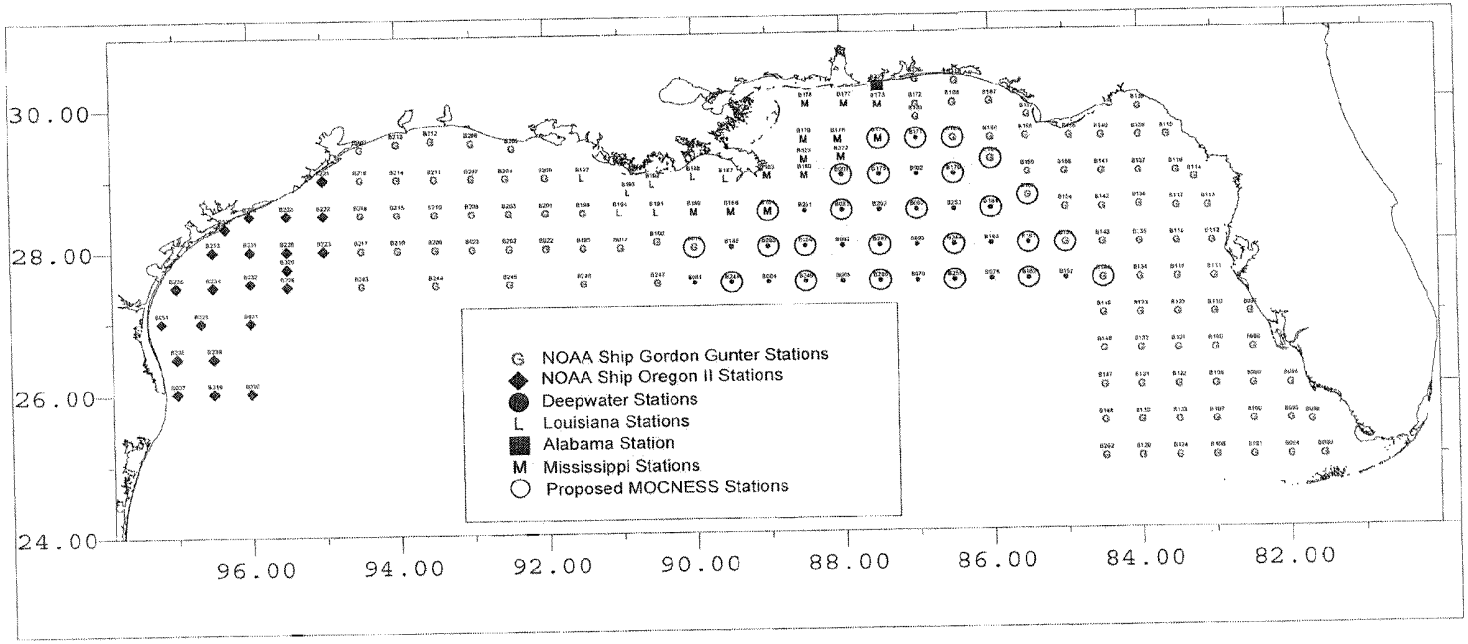

Figure 3. Fall plankton SEAMAP stations and additional deepwater stations to fill in gap where spill occurred. Symbols represent various ships/state SEAMAP partners and additional MOCNESS sampling sites. Note: stations to be sampled for the proposed cruise aboard the R/V Gordon Gunter, are marked as a red G (G NOAA Ship Gordon Gunter Stations) and a black dot (• Deepwater Stations). Stations with a black circle around them will be sampled with the MOCNESS (top 130m).

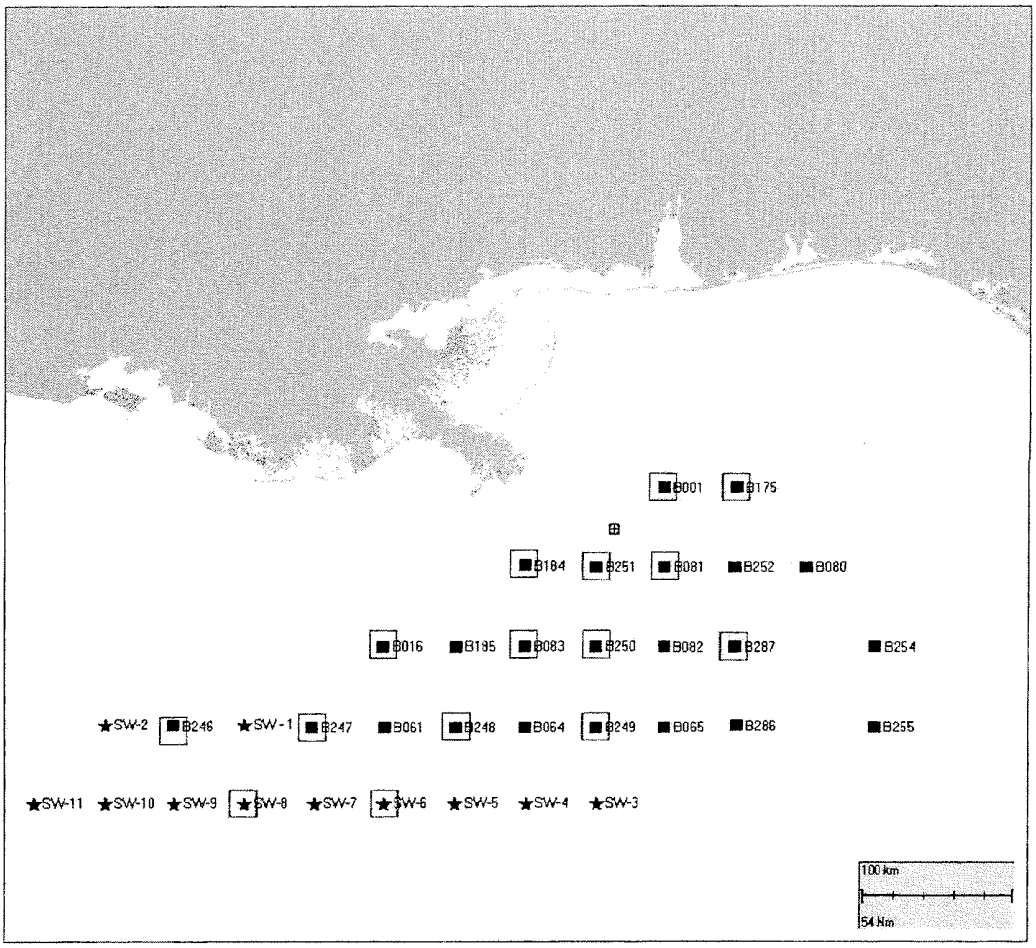

Figure 4. Deepwater stations sampled by the *Gordon Gunter* (solid black squares) and additional offshore stations to the SW (stars). SW stations (stars) were added by extending the SEAMAP grid (30nm x 30nm) to the south to obtain more sample coverage in offshore areas. Deep-tow stations (1500m) sampled on the *Walton Smith* 1 and planned for Walton Smith 3 are outlined by squares: red-purple for *Walton Smith* 1 and blue for *Walton Smith* 3 (this work plan).

Table 1. Coordinates of deepwater stations to be sampled during Walton Smith 3 Cruise (listed in order of sampling).

Station Number	Longitude	Latitude
SW-8	[redacted]	[redacted]
SW-6	[redacted]	[redacted]
B249	[redacted]	[redacted]
B287	[redacted]	[redacted]
B175	[redacted]	[redacted]
B251	[redacted]	[redacted]

Sampling Procedures

MOCNESS: Vertical distribution of plankton in the entire water column will be measured by sampling at depth discrete intervals at a subset of the added offshore stations using a 1 m Multiple Opening and Closing Net and Environmental Sensing System (MOCNESS) (333 μm mesh). The MOCNESS is an instrumented net system that is capable of taking discrete samples over specific depth strata (Figure 5). 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 11.

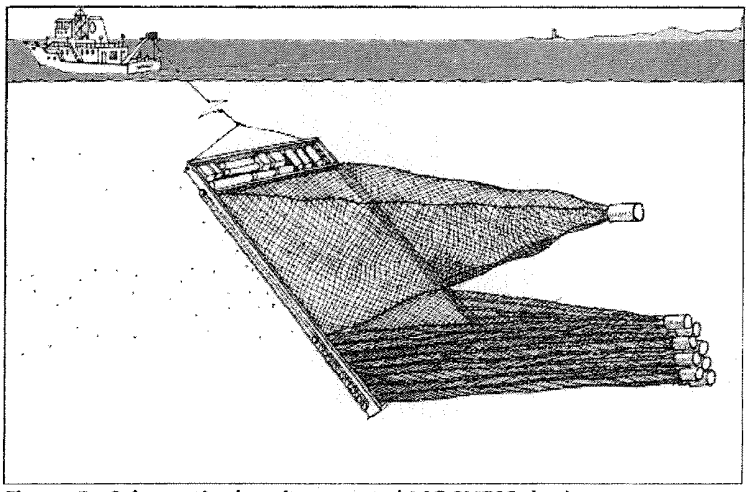

Figure 5. Schematic showing general MOCNESS deployment.

The MOCNESS will be towed obliquely through the water column from a maximum depth of 1500m. The first net (net 0) will be open all the way down to 1500m. Upon commencing the oblique tow back to the surface, the second net will be opened and cover the depth range from 1500m to 1200m. Additional nets will be opened and closed at depth intervals of 200m until the epipelagic zone lower limit (at 200m). The epipelagic zone will be split into two depth intervals 200-25m and 25-0m (Table 2). While the bottom depth at the different stations will vary, the maximal depth of 1500m is near bottom for most all the stations and using standard depth bins at all stations allows us to compare the data between stations. The depth bins are spaced to achieve the highest resolution possible in the deep water column with the limitation of nine nets. The upper two depth bins of 200-25m and 25-0m were chosen as they are the same depth strata sampled by nets in the SEAMAP program and this will allow us to directly compare out data to the SEAMAP data. The upper 25m net allows resolution of the community in the upper mixed layer, which would have been most exposed by re-entrained floating oil.

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. After the sampling is completed at one station, we will transit to the next station and will be there in time to repeat our day night sampling at that station. Thus, samples will be obtained both in daylight and during the night. The changes in densities due to the diel cycle of zooplankton vertical migration will be evident in these data.

Table 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

Laboratory Analysis of Plankton (post cruise): In the laboratory, the samples will be removed from the formalin and rinsed. The sample will then be transferred to a sorting tray and all ichthyoplankton will be removed. The ichthyoplankton will placed on the scanning tray of a Zooscan and scanned to create a digital record. They will then be placed in a vial with 70% ethanol and transferred to an expert for analysis. For detailed Zooscan methodology see Attachment 2.

The remainder of the sample will be split into ¼ subsamples (or further if necessary) and all the subsamples will be scanned with the Zooscan to create a digital record of the entire sample. A randomly selected subsample will then be further split to obtain a subsample that can be readily spread on the scanning surface so that few individuals are touching or overlapping. This will be scanned and then processed using automated measuring and identification techniques in the Zooprocess software.

The entire sample will then be returned to the sample jar and preserved in 4% formalin for archival purposes.

This analysis will results in an estimate of biomass and taxonomic composition for each sample. Further analyses can be performed on the physical sample to identify organisms to species level.

CTD: We will deploy to full ocean depth a Seabird CTD profiling package (which can be deployed to a depth of 6000 meters) to collect dissolved oxygen, and salinity, temperature, and depth information.

Aquatracka: The Chelsea Aquatracka (to be attached to CTD array, Attachment 3) will be used in profiling mode (to full ocean depth), to detect fluorescence from submerged oil and/or dissolved components. These measurements will complement similar profiling activities performed on other cruises (e.g., Hos Davis 1 &2), as described elsewhere.

Water Samples: If peaks in the Aquatracka signal are seen, water samples will be taken in these depth levels. From each Niskin sampling bottle, water samples will be taken for

1) PAHs (whole water, unfiltered) and VOAs (in duplicate) (Attachment 13);
2) filtered and unfiltered nutrients, total suspended particulates, dissolved organic carbon, micronutirents and trace metals (Attachment 14).

Surface Plankton Sampling: Samples from the shipboard flow-through system (fixed intake below the hull of the ship 1 M deep) will be collected as time permits. We will collect whole-water samples for

quantitative enumeration of phytoplankton, microzooplanton, and mesozooplantkon at various times throughout the duration of the cruise (while underway, while towing MOCNESS, or during CTD deployment). Whole water samples will be collected fresh and analyzed immediately in a FlowCAM (imaging microscope system) and two aliquots will be preserved in acid Lugols and buffered formalin for later analysis. Water will be filtered through a 20 μm mesh (approximately 300 L) and preserved in buffered formalin for analysis of mesozooplankton. Methods and analyses are described in Attachment 2.

Radiometer: UV light measurements will be taken using the BioOPS profiling reflectance radiometer supplied by Biospherical Instruments (BSI). Vertical profiles from 0 to up to 30 m will be made in daytime between plankton sampling deployments (early morning and later afternoon) at the same stations or opportunistically in midday, as time permits (see Attachment 12).

Personnel for R/V *Walton Smith* 3 (12 Science Berths Available):

NOAA Contractors

Dr. Malinda Sutor (LSU), Chief Scientist
Dr Deborah French McCay (ASA), Scientist
Eileen Graham (ASA, Radiometer technician and Data Manager)
Alvaro Armas, Kate Lingoni (LSU Technicians)
Fred Marin (NOAA contractor)
Mimi Tzeng (NRDA Water Sampler)
Sean Leatham (NRDA NOAA contractor)

1 ENTRIX employee (Kristen Morrison)

Boat Crew from University of Miami (captain, mate, deck hands)

Vessel

Operations will be completed on the NOAA vessel R/V *Walton Smith* (Attachment 4)

Estimated Costs:

Costs	Hrs/Days/Trips	Day/Hr Rate	Total
CSA Labor			
Leased Equipment (LSU): FlowCam	1	$	$3000
Other Direct Costs (LSU)	1	$	$2000
Total			**$5,000**

Field Survey Costs	Hrs/Days/Trips	Day/Hr Rate	Total
Walton Smith	8	$12,000	$ 84,000
NOAA Labor (days):			
Malinda Sutor	[redacted]	[redacted]	$ 16,000
LSU Technicians (K. Lingoni)	[redacted]	[redacted]	$ 16,000
LSU data analysis (Sutor and techs)			$ 75,000
Deborah French McCay	[redacted]	[redacted]	$ 16,000
Eileen Graham	[redacted]	[redacted]	$ 8,000

NOAA technician (Fred Marin)	[redacted]	[redacted]	$ 8,000
NOAA technician (Mimi Tzeng)	[redacted]	[redacted]	$ 8,000
NOAA technician (Sean Leatham)	[redacted]	[redacted]	$ 8,000
Misc Costs Sample Handling	1	$11,000	$11,000
Travel (ASA)	[redacted]	[redacted]	$3,000
Total			**$275,000**
TOTAL			**$280,000**

Days/Trips based on [redacted]
Labor is estimated cost and hours
Ships crew, Food, & Fuel estimates included in day rate

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.

Safety Plans
BP's full operations and safety plan is attached along with incident reporting form, SIMOPS protocols, and transfer protocols. In addition, the NOAA incident site safety plan (which all NOAA employees and contractors must sign prior to the cruise) is attached (Attachment 1).

Transfer of the shared electronic media in the onboard equipment to each of the party's hardware for retention and use.
Upon return to port, the vessel Operations Manager shall produce identical copies of the raw and processed electronic media generated during the cruise and deliver one of those copies each to NOAA (or its QA contractor) and to ENTRIX.

Laboratory
Plankton samples will be stored and analyzed at Dr. Malinda Sutor's laboratory at Louisiana State University in Baton Rouge, LA. Official NRDA chain of custody procedures will be followed for any transfer of samples from ship to laboratory. When water samples are taken, procedures of the Hos Davis 2 plan will be followed. Water sample intake will be coordinated through standard NRDA field operations and procedures and shipped to the appropriate laboratory for analysis.

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 ENTRIX 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 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 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. Also, the LADP shall not be released by the DMT, LOSCO, BP or 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 ENTRIX on behalf of BP).

References

Broughton EA, Lough RG. 2006. A direct comparison of MOCNESS and Video Plankton Recorder zooplankton abundance estimates: Possible applications for augmenting net sampling with video systems. Deep Sea Research Part II: Topical Studies in Oceanography, 53, 2789–2807

Attachments:

Attachment 1. Summary of Historical Shelf and Offshore Plankton Data
Attachment 2. Sutor-Optics Acoustics-2010Aug19.doc
Attachment 3. Chelsea Aquatracka Fluorometer
Attachment 4. FGWaltonSmith_ShipSpecs
Attachment 5. NOAA-NRDA_MC_252_Site_Safety_Plan_5.13.10
Attachment 6. NRDA_Field_Sampler_Data_Management_Protocol_7_5_2010
Attachment 7. MC 252_Incident_SIMOPS_Plan_May10_2010_Rev2 (2)
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 V2.1
Attachment 11. Mocness_Deployment_Protocol.doc
Attachment 12. BioOps Radiometer
Attachment 13. Water Sampling Protocols
Attachment 14. Procedures for Nutrients, Carbon, Suspended Particulates, and Trace Metals

Deepwater Horizon Oil Spill (DWHOS)

NRDA Plankton Sampling Plan
& Fall 2010 Cruise Plan

Walton Smith 3

Water Column Technical Working Group

Cruise Dates: September 26-October 3, 2010

Plan Date: November 15, 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	Cook Fay Printed Name	Cook Fay Signature	11/19/10 Date
Federal Trustee Approval	Jessica White Printed Name	Jessica White Signature	11/17/10 Date
Louisiana Approval	HAROLD DEBOUSSCHERE Printed Name	for NOLAND GUIDRY Signature	2/10/11 Date