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

NRDA Winter 2011 Plankton Imaging Sampling Cruise Plan

Sampling Vessel: M/V *Arctic*

January 12, 2011

Prepared by:
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Reviewed by:
Dan Hahn, John Quinlan (NOAA)
William Graeber, Jeffery Simms (Cardno ENTRIX) on behalf of BP

Proposed Cruise Dates
January 13 – January 27, 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.

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).

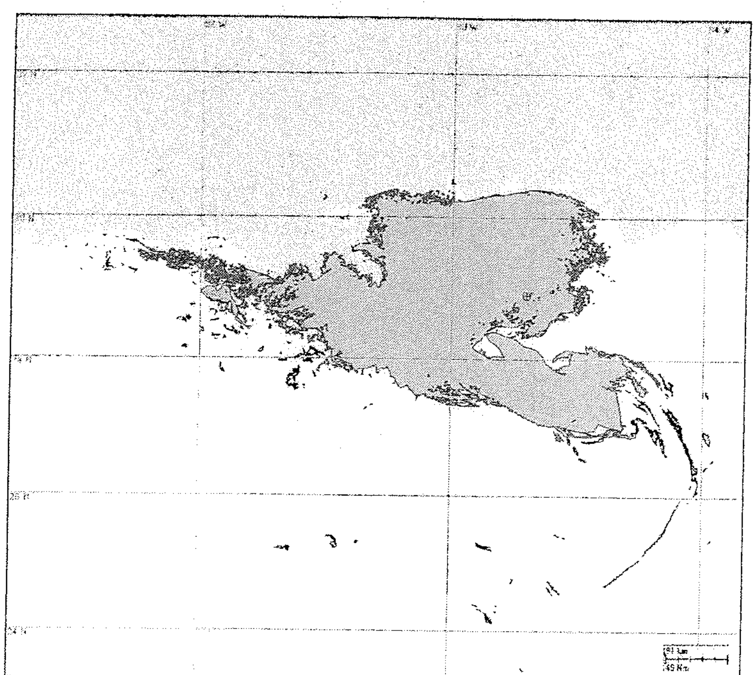

Figure 1. Cumulative potential surface floating oil extent of the Deepwater Horizon oil spill. (Figure derived from compositing April, May, June, and July 2010 radar shape files available on the NOAA ERMA website. Note that radar images with noted anomalies were not included in composite.)

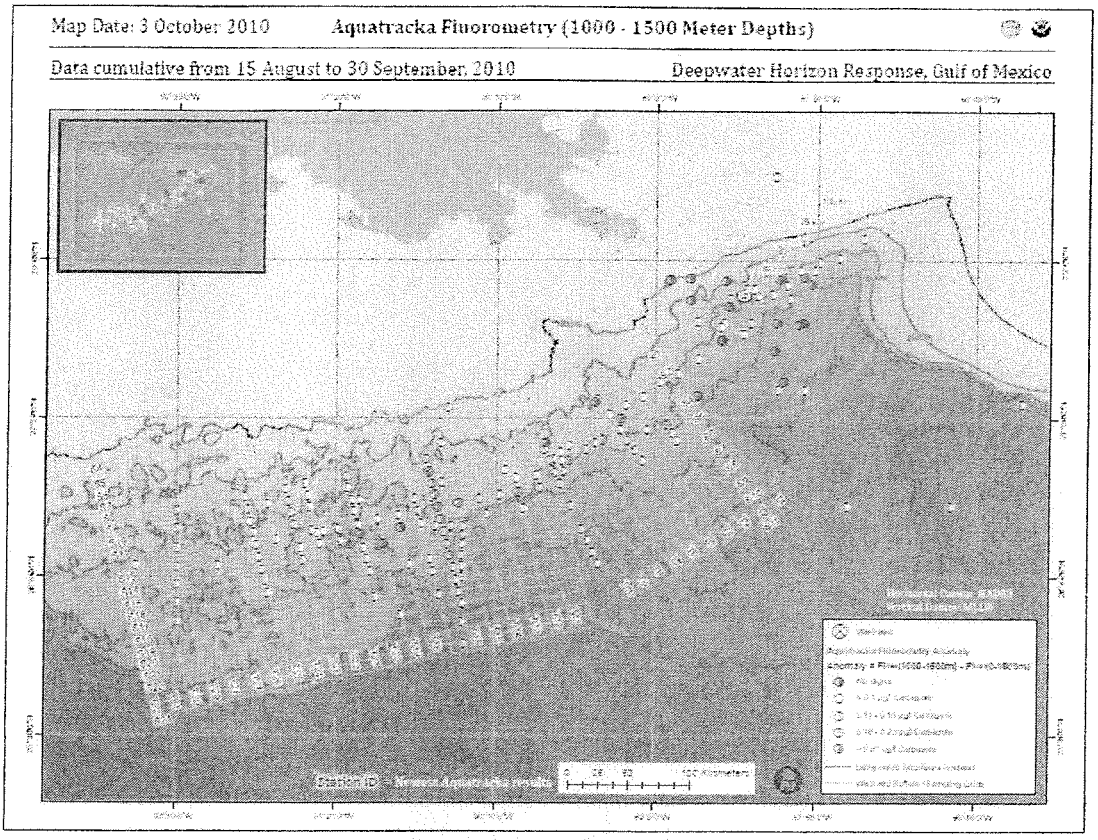

Figure 2. Cumulative summary of Aquatracka fluorescence measurements between 1000 and 1500m, 15 August to 30 September 2010.

Objectives and Approach

This plan is part of a series of cruises scheduled for the winter of 2011 intended to evaluate the distribution and densities of ichthyoplankton, other zooplankton and some phytoplankton (> ~50μm) 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 9). 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 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. Other data gaps include the underrepresentation of soft bodied organisms and marine snow in net-based surveys. A series of cruises in the fall of 2010 (aboard *Walton Smith* and *HOS Davis*) targeted all of these data gaps through the deployment of the color digital-autonomous video plankton recorder (DAVPR). Comparative studies between 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, whereas these delicate groups are destroyed or damaged beyond recognition in net samples.

This plan, the winter 2011 M/V *Arctic* plankton imaging sampling plan, describes the sampling effort for winter 2011. The primary objective of the cruise is to collect plankton image data using the digital-autonomous Video Plankton Recorder (DAVPR) and the Holocam (Attachment 10). The occurrence, abundance, biomass, and vertical distribution, of plankton and marine snow in the Gulf of Mexico will be assessed. The over-arching plan is to conduct sampling in each season, utilizing several sampling methods (e.g. MOCNESS, bongo net, neuston net, and imaging systems). The duration of the program with respect to the number of years is 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.

Methodology

Sampling Stations

The DAVPR will be towed along 12 NM transects that run perpendicular to the depth contours of the continental slope (Figure 3). Transects straddle the 1200m bathymetric contour, and transects SW of the well site run through the subsurface plume axis that was observed in August-September 2010 (Figure 2). The DAVPR transects are numbered from east to west and priority of sampling will be determined by the chief scientist, Dr. Cabell Davis, onboard. Specific locations of the transects may be adjusted slightly, based on logistics and maps of bottom areas of interest, as they become available. In case of additional available time during the cruise, Figure 3 also depicts the deep water transects run by SIPPER on the *Specialty Diver* 1 cruise in September 2010, which will be sampled as part of the winter 2011 plan.

At selected locations, comparative sampling will take place along-side and in conjunction with the *Nick Skansi*, which will be using a 1-m MOCNESS system. These side-by-side samplings will allow for a direct correlation of data collected by both sampling systems and allow inter-calibration of gear types. Numbered stations in Figure 3, where the *Nick Skansi* will be sampling with the 1-m MOCNESS, are those closest to the DAVPR transects. These side-by-side sampling events will be organized directly between Dr. Malinda Sutor, chief scientist for the *Nick Skansi* cruise and Dr. Cabell Davis, chief scientist for the M/V *Arctic* cruise.

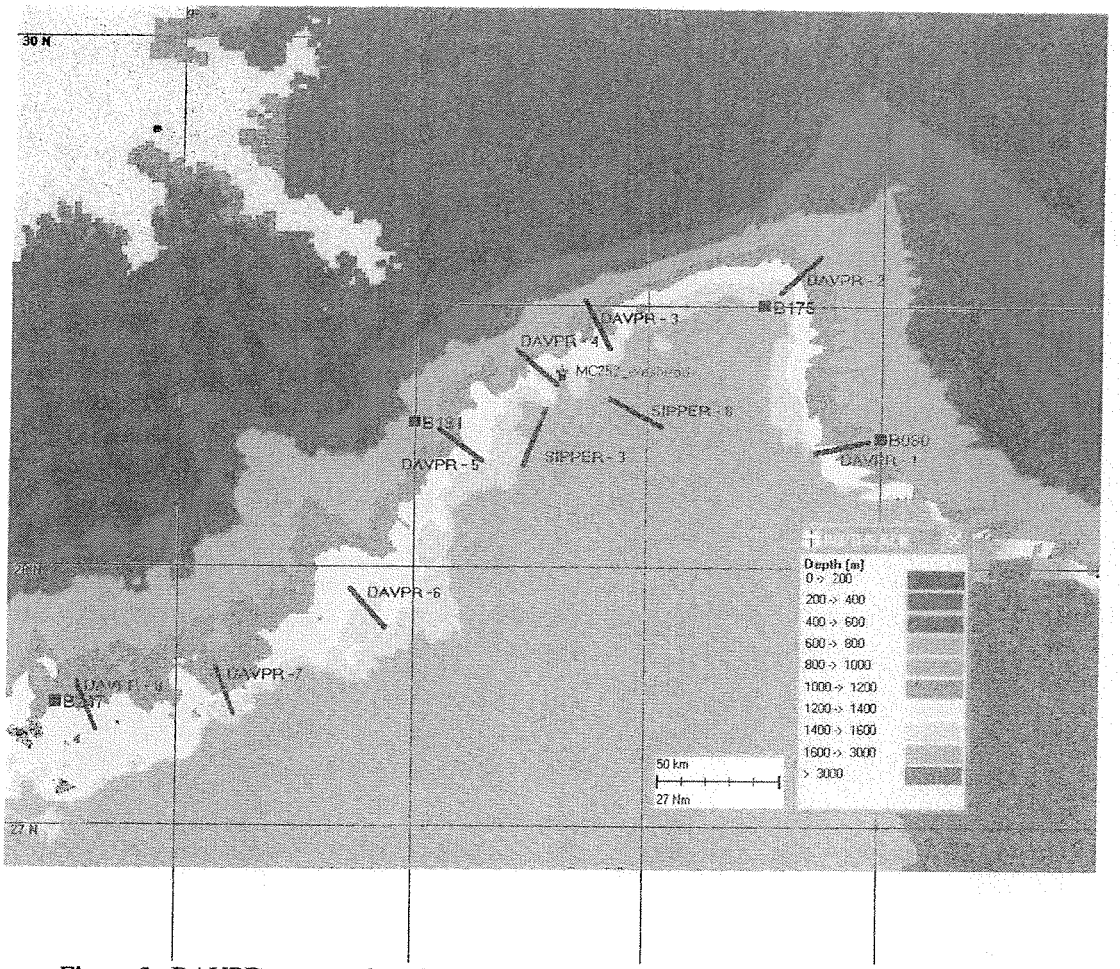

Figure 3. DAVPR transect locations along the slope. Each transect straddles the 1200m bathymetric contour and is approximately 12 NM in length. SIPPER transects (*Specialty Diver* 1 Cruise) and Deep MOCNESS stations (square icons, *Walton Smith* 1 & 3, *Nick Skansi* Plankton III & IV) are also depicted.

Sampling Procedures

DAVPR: A color Digital-Autonomous Video Plankton Recorder (DAVPR) will be used to survey the distribution of plankton and marine snow (Cabell Davis, WHOI). See Attachment 10 for a description of the instrument, specifications, and deployment procedure. The DAVPR is towed behind the vessel and undulates through the water column in a tow-yo or saw-tooth profile pattern. It is capable of reaching a depth of 1200m, so it its towed from 0m to 1200m. Each transect will be sampled twice: once 9am-3pm, and again 9pm-3am. This will require day and night operations.

CTD: The DAVPR will be mounted on the Seabird SBE911+ CTD profiling package to collect high-resolution water characterization data. The following sensors are to be deployed with this package, as logistically feasible: Aquatracka (see next paragraph), turbidity, chlorophyll fluorometer, transmissometer, ABS (see below), dissolved oxygen, and salinity, temperature, and depth information.

Aquatracka: The Chelsea Aquatracka (Attachment 11) will be attached to DAVPR/CTD frame 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.

ABS: The Aquascat 1000 (ABS, Attachment 12) to detect and quantify the presence of particles, *in situ.*

Holocam: The holocamera (Holocam, Attachment 10) is an underwater digital holographic imaging camera developed to image plankton and particles ranging in size from a few microns to several centimeters. It may be attached to the CTD package or towed cable to capture *in situ* images continuously.

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 (Attachment 7).

Logistics

Vessel:

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

Personnel for M/V Arctic (20 Science/Operations Berths Available):

NOAA Contractors:

- Dr. Cabell Davis, Chief Scientist
- Kate Lingoni (LSU, DAVPR Technician)
- Fred Marin (AIS, DAVPR Technician)
- Data Manager (Dade Moeller)

Cardno ENTRIX Employees:

- 2 (Observers)

CSA Operational Staff: none

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]	$37,500
2 DAVPR Technicians	[redacted]	[redacted]	$45,000
1 Data Manager	[redacted]	[redacted]	$22,500
Equipment rental (DAVPR)	20	$500	$10,000
Travel	1	$10,000	$10,000
TOTAL			**$125,000**

Days/Trips based on 1 day mobilization, 13 sampling days, 1 day demobilization.
Labor is estimated cost and hours.

Budget Chart #2.

Vessel Costs	Total
Mobilization Costs	$210,000
Vessel Costs	$1,307,789
CSA Fleet Mgmt / Shore Support	$210,000
Total Estimated Cost	**$1,727,789**

Fuel & Lube estimates included in Vessel Cost
Vessel Costs for standby thru February 10, 2011 included

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).

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. NRDA_Ops_Safety_Plan_08DEC2010
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. Davis-VPR Holography-2010Dec9
Attachment 11. Chelsea Aquatracka Fluorometer
Attachment 12. Acoustic Backscattering Sensor (ABS)

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Sampling Vessel: M/V *Arctic*

Cruise Dates: January 13-27, 2011

Plan Date: January 12, 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 — Lawrence Mahoor (Printed Name) — Signature — Jan. 13, 2011 (Date)

Federal Trustee Approval — [illegible] (Printed Name) — [illegible] (Signature) — 1/13/2011 (Date)

Louisiana Approval — KAROLIEN DEBUSSCHERE (Printed Name) — FOR ROLAND GUIDRY (Signature) — 2/14/2011 (Date)