Offshore Zooplankton and Ichthyoplankton Characterization Plan: Deepwater Horizon Oil Spill Plankton Cruise IV June 17, 2013

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Cruise dates: October 15 – 28, 2010 (14 days)

Study Overview

The Offshore Zooplankton and Ichthyoplankton Characterization Plan is an effort to collect data that will be used to describe the plankton assemblage in the northern Gulf of Mexico (GOM) and to inform the evaluation of potential impacts from the Deepwater Horizon Oil Spill (DHOS) to the zooplankton and ichthyoplankton in the region. Characteristics of the plankton assemblage that may be assessed include: 1) depth-discrete and depth-integrated biomass; 2) depth-discrete, depth-integrated and near-surface distribution and densities by taxon and life stage; and 3) morphometric measurements of larval fishes, gelatinous zooplankton (including Ctenophora and Hydrozoa), and commercially important decapods[1].

Objectives

The primary objectives of Plankton Cruise IV are to collect data that will be used to characterize the plankton assemblage including: horizontal, vertical & diel distribution and abundance patterns of larval, post-larval, and juvenile stages of fish and all stages of zooplankton. In addition, the cruise may test methods for estimating the natural mortality rates of copepod species in the GOM[2].

Included in these objectives, and in cooperation with the NOAA Enhanced SEAMAP sampling plan and specific to the fall cruise season, the samples and data collected may enable assessments of the occurrence, abundance, and distribution of the early life stages of fall-spawning fishes, such as the king and Spanish mackerel, red drum, and snappers. Similarly, early life stages of commercially important invertebrates (lobsters, decapods) may also be assessed in the area of

[1] The scope of this cruise work plan is biological sample and associated field data collections. All samples collected under this plan fall under the purview of the NRDA Plankton Processing Plan, January 2012 and addenda.
[2] The Trustees did not support the method for estimating natural mortality of copepods as proposed in this plan. In acknowledgement of the Trustees concerns for the methods as described, the analysis was not performed during the survey. The section remains in the work plan as documentation of the work plan as it existed at the time of the survey.

potential effects. Sample and data processing are not addressed in this work plan (see footnote 1).

Study Elements

The primary components of this sampling plan include:

A. Collect samples to help determine the vertical distribution of zooplankton and ichthyoplankton densities by species and life stage or lowest-possible taxonomic group, during both daytime and nighttime hours, via depth stratified plankton sampling using a 1-meter Multiple Opening and Closing Net and Environmental Sensing System (MOCNESS) fitted with 333-µm mesh nets.

B. Collect samples to help determine taxonomic composition, densities and biomass of the zooplankton and the densities of both larval and post-larval stages of ichthyoplankton and decapods using paired 61 cm bongo nets fitted with 333-µm mesh.

C. Collect samples to help determine taxonomic composition, densities and biomass of the zooplankton and the densities of post-larval and early juvenile stages of commercially important fishes and decapods using neuston net (1000-µm mesh) gear.

Study Design

Bongo and Neuston Sampling

A probabilistic approach will be employed to enable structured random sampling of the study area. This approach will incorporate the USEPA's Generalized Random Tessellation Stratified (GRTS) Spatially-Balanced Survey Designs for Aquatic Resources (Appendix A)[3].

MOCNESS Sampling

MOCNESS sampling locations were chosen in coordination with NOAA and based on the NOAA/NMFS SEAMAP 2010 fall plankton survey locations (Appendix B and C). 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 Nautical mile (NM), with sampling stations located at the mid-point of each grid cell. Additional deepwater stations were added to the SEAMAP grid to help fill the data gaps for sampling surface waters (>200M) in the offshore areas in the vicinity of the MC 252 wellhead. These additional offshore stations will target MOCNESS sampling from 0 to 1500 meters, collecting samples from the mesopelagic as well as epipelagic zones.

Location

[3] The Trustees did not support the GRTS method for offshore plankton sampling site selection as proposed in this plan. However, the GRTS sampling design was utilized during this survey so remains in this plan as a description of methods.

Bongo and Neuston Sampling

Bongo and neuston net sampling will be conducted aboard the *M/V Sarah Bordelon* & *M/V Meg Skansi* and will sample 50 sites within a study area near the release site selected based upon preliminary analysis of sea surface oil data (Figure 1). Realizing the locations of observed floating oil do not necessarily delineate or include all areas where subsurface exposures occurred, Figure 1 provides only guidance to areas where near-surface exposures may have occurred. In this work plan, 25 additional deepwater stations were added to the selected locations in the event that additional sampling time is available. These data will be used in conjunction with the NOAA/NMFS SEAMAP 2010 fall plankton survey with the GRTS design supplementing the SEAMAP grid-based system. See Appendix A for site selection methodology.

MOCNESS Sampling

MOCNESS sampling will be conducted by the *M/V Nick Skansi*. Twenty-four sites from the SEAMAP sampling grid have been selected as MOCNESS sampling locations for the fall 2010 plankton survey (Table 1, Figure 2). Twelve sites will be sampled, day and night, during plankton cruise III with the remaining twelve sites sampled during plankton cruise IV (Figure 2). Sites indicated with a cyan border have been classified as lower priority sites due to their distance from the well (Figure 2) and will be sampled during the final 2 days of each survey weather permitting.

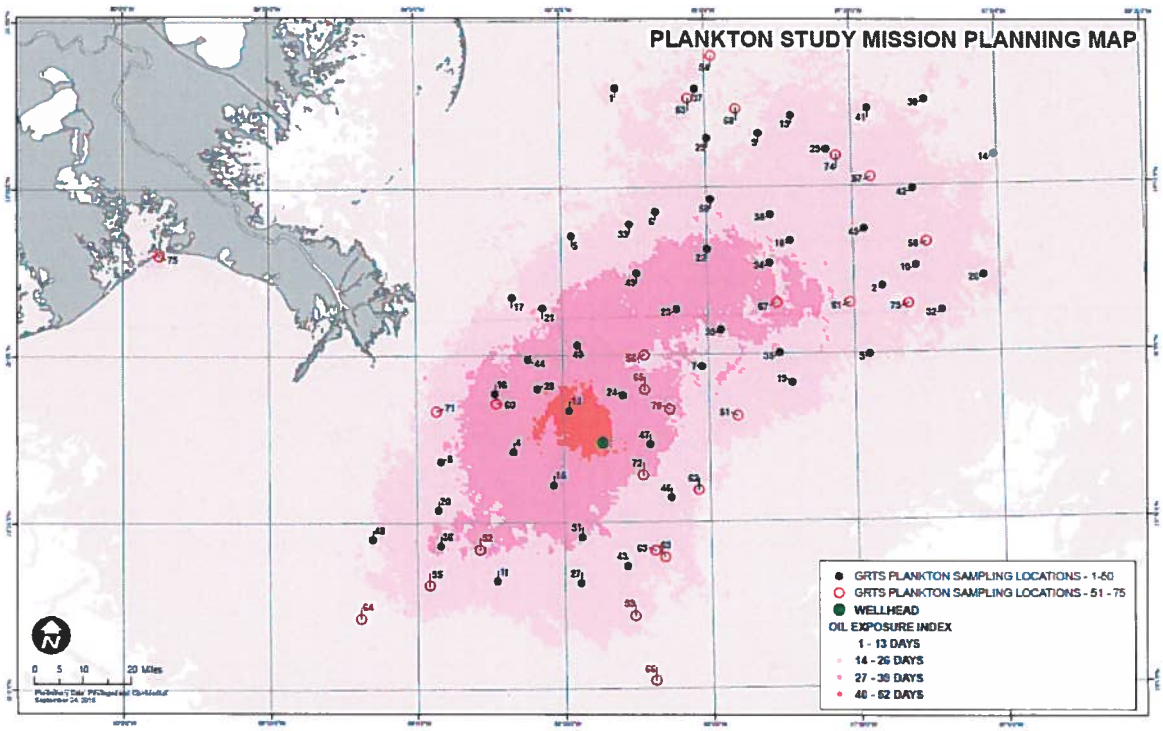

Figure 1: Bongo & neuston sampling sites for fall 2010 Offshore Zooplankton and Ichthyoplankton plan

Station	Longitude	Latitude	Station	Longitude	Latitude
B245	92° 30' W	27° 30' N	B248	89° 30' W	27° 30' N
SW11	92° 30' W	27° 00' N	SW5	89° 30' W	27° 00' N
SW2	92° 00' W	27° 30' N	B184	89° 00' W	28° 30' N
SW10	92° 00' W	27° 00' N	B083	89° 00' W	28° 00' N
SW9	91° 30' W	27° 00' N	B064	89° 00' W	27° 30' N
SW1	91° 00' W	27° 30' N	SW4	89° 00' W	27° 00' N
SW8	91° 00' W	27° 00' N	B251	88° 30' W	28° 30' N
B247	90° 30' W	27° 30' N	B250	88° 30' W	28° 00' N
SW7	90° 30' W	27° 00' N	SW3	88° 30' W	27° 00' N
B061	90° 00' W	27° 30' N	B082	88° 00' W	28° 00' N
SW6	90° 00' W	27° 00' N	B065	88° 00' W	27° 30' N
B185	89° 30' W	28° 00' N	B252	87° 30' W	28° 30' N

Table 1: MOCNESS sampling sites for fall 2010 Offshore Zooplankton and Ichthyoplankton plan

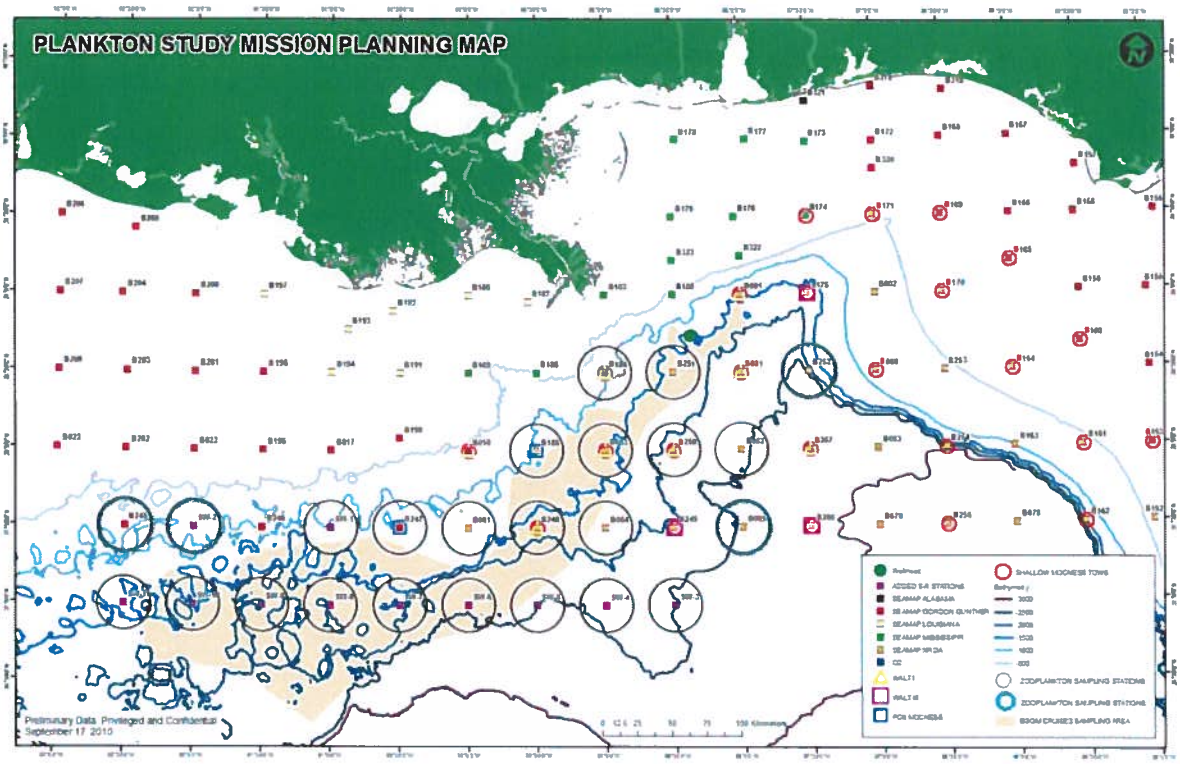

Figure 2: MOCNESS sampling sites for fall 2010 Offshore Zooplankton and Ichthyoplankton plan

Methods

Standard Operating Procedures (SOPs) for all gear types can be found in Appendix E.

Gear Types

In order to obtain broader knowledge of the plankton assemblage of the northern GOM, three types of net gear will be utilized:

1) MOCNESS:

The MOCNESS (Figure 3) is a computer-controlled multi-net system with an in-situ electronics package which enables collection of plankton samples from specific depth intervals in the water column along with real-time measurements of environmental parameters. The system consists of nine 333-µm mesh size nets each with a 1 m^2 mouth.

Figure 3: The Multiple Opening/Closing Net and Environmental Sensing System (MOCNESS) Photo: University of California, San Diego: http://sioscope.ucsd.edu/resources/sampling/MOCNESS.jpg

The standard methodology used in this sampling plan for the MOCNESS follows the NOAA NRDA protocols developed for deep MOCNESS sampling (Appendix C). To deploy the MOCNESS, the first net (Net 0) will remain open during deployment to the maximum sampling depth of 1500 m at which point Net 0 will be triggered to close and Net 1 will open for ascent. The MOCNESS will be towed obliquely to the next depth

strata (Net 2, Table 2) where Net 1 will be closed and Net 2 will be opened. This process will be repeated at discrete depth intervals (Table 2) until the MOCNESS reaches the surface.

A Simrad EK60 single-beam echosounder will be used during MOCNESS sampling to record water column acoustic backscatter and identify density differences of backscatter sources that may represent plumes containing gas (e.g., from seeps) or biota (Appendix D).

At stations where the bottom depth is less than the maximal depth range for a predefined strata, the depth range of the deepest net shall be from approximately 10 m above the bottom (or the deepest depth possible given deployment conditions and maintaining safety of the MOCNESS) to the minimal depth range of the predefined strata. All shallower depth strata will be sampled according to predefined depth ranges (Table 3).

Net 0	0 m – 1500 m or within 10 m of seafloor
Net 1	1500 m – 1200 m
Net 2	1200 m – 1000 m
Net 3	1000 m – 800 m
Net 4	800 m – 600 m
Net 5	600 m – 400 m
Net 6	400 m – 200 m
Net 7	200 m – 25 m
Net 8	25 m – 0 m

Table 2: Standard MOCNESS depth bins

Net 0	0 m – 1000 m or within 10 m of seafloor
Net 1	1000 m – 800 m
Net 2	800 m – 600 m
Net 3	600 m – 400 m
Net 4	400 m – 200 m
Net 5	200 m – 25 m
Net 6	25 m – 0 m

Table 3: MOCNESS depth bins – adjusted for depth

2) Bongo nets:
The standard methodology used for bongo collections in this sampling plan follows the NOAA/NMFS SEAMAP Plankton Sampling Protocols (Appendix G). Briefly, a paired 61-cm bongo frame (Figure 4) fitted with 333-µm mesh nets will be towed in an oblique pattern from a depth of 200 m (or 10 m off the seafloor, whichever is shallower). A depth sensor mounted to the bongo frame will record depth while a mechanical flowmeter, mounted in the mouth of each bongo net, will be used to calculate the volume of water filtered (m^3). The ship will maintain a speed of 1.5 - 2.0 knots during deployment and retrieval with adjustments made during the tow to maintain an optimal wire angle of 45°. The same gear system will be used to conduct a bongo tow to 25 m depth. At select

stations an additional 0 - 200 m bongo tow may be conducted to obtain samples to test methods for estimating natural mortality rates of copepods (see footnote 2).

Figure 4: Paired 61 cm bongo nets

Photo: http://oceanexplorer.noaa.gov/explorations/07philippines/logs/oct5/media/bongonets_600.jpg

3) Neuston net:
The standard methodology used for neuston collections in this sampling plan follows the NOAA/NMFS SEAMAP Plankton Sampling Protocols (Appendix G). The neuston net (Figure 5) consists of a 2 m x 1 m steel frame fitted with a 1000-µm mesh net designed to sample the top meter of the water column. The neuston net will be deployed off the starboard side and towed at the surface maintaining a minimum depth of 0.5 m. A flowmeter mounted in the lower third of the net and will be used to calculate the volume of water filtered (m^3). The ship will maintain a speed of 1.5 - 2 knots, adjusted to maintain the depth of the net. The neuston net will be towed for 10 minutes, although this may be shortened if the net becomes clogged with jellyfish, seaweed, or flotsam.

Figure 5: 2m x 1m Neuston net

Photo: http://oceanexplorer.noaa.gov/explorations/02sab/logs/aug07/media/neuston2_600.jpg

Gear Deployment

The MOCNESS, bongo (200 and 25 m), and neuston gears will be deployed at their assigned sampling locations. Samples will be collected continuously during both daytime and nighttime

periods. Daytime is defined as from two hours after sunrise to two hours before sunset, and nighttime is defined as two hours after sunset to two hours before sunrise at each location.

A Seabird CTD profiler will be deployed separate from net gear at each bongo/neuston sampling site to record Conductivity, Temperature, Depth, Dissolved Oxygen, and Colored Dissolved Organic Matter in order to characterize water column properties and physicochemical parameters. Separate CTD casts will not be conducted at MOCNESS sampling sites as environmental parameters will be recorded by the system's in-situ electronics package[4]. CTD casts are to be performed while the vessel is held in position using Dynamic Positioning[5].

Sample Handling

MOCNESS samples will be analyzed for plankton biomass as well as zooplankton and ichthyoplankton taxonomy. Each sample from Net 1 – Net 8 will be fixed in 3.7% formaldehyde (1 part 37% formaldehyde: 9 parts seawater) for biomass analysis and taxonomic identification of zooplankton and ichthyoplankton. The sample from Net Ø, which is open during descent, will be immediately preserved in 70% ethanol and the supernatant decanted after 24 hours and replaced with fresh 95% ethanol. The samples from paired bongo nets will be fixed in 3.7% formaldehyde (1 part 37% formaldehyde: 9 parts seawater).

At select stations an additional 0 - 200 m bongo tow may be conducted to obtain samples for estimating natural mortality rates of copepods. This sample will be stained with Neutral Red to test methods for estimating natural mortality rates of copepod species (Appendix E) (see footnote 2).

Neuston samples will be fixed in 3.7% formaldehyde.

During sampling the catch from any deployment that cannot be used for quantitative NRDA purposes will be retained as non-quantitative samples[6].

Trustee representative(s) will observe and assist with sample collection. All samples will be held under chain of custody by the Trustee representative(s) on board the ship, as well as on shore during analysis and while archived (see footnote 1).

Logistics

Schedule

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[4] The Trustees preferred separate CTD casts be performed at all sampling locations, regardless of gear type. However, the sampling methods described in this paragraph were implemented during the Plankton Cruise III.

[5] The Trustees preferred CTD casts be performed while drifting because the trawls are performed over a tow path and the objective is to characterize the water properties over the general are of the tow.

[6] These non-quantitative samples fall under the purview of the NRDA Plankton Processing Plan, January 2012 and addenda. They were collected with each gear type for potential use in laboratory analyses. Non-quantitative samples were preserved in the same manner as quantitative samples of the same gear.

Mobilization and return dates for Cruise IV personnel are October 15 – October 26, 2010 for the M/V *Meg Skansi* and M/V *Sarah Bordelon* and October 15 – October 28, 2010 for the M/V *Nick Skansi*. The twelve and fourteen days of ship time, respectively, include 2 partial days of transit time and 10 days of bongo/neuston sampling and 12 days of MOCNESS sampling.

Personnel

The personnel list can be found in Appendix F.

Vessels

Bongo and neuston sampling will be conducted by the M/V *Meg Skansi* and M/V *Sarah Bordelon* and MOCNESS sampling will be completed by the M/V *Nick Skansi*. All vessels are operated by Skansi Marine, New Orleans, LA.

Safety Plan

A full operations and safety plan can be found in Appendix H.

Sample Custody

Samples will be transferred to, and held under chain of custody by Dr. Malinda Sutor of the Department of Oceanography and Coastal Sciences of Louisiana State University (LSU) until a separate plan for sample processing is developed.

Data Management

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.

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 (AQAP), 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 AQAP 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 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).

Sample Retention

All materials associated with the collection or analysis of samples under these protocols or pursuant to any approved work plan, including any remains of samples and, including remains of extracts created during or remaining after analytical testing, must be preserved and disposed of in accordance with the preservation and disposal requirements set forth in Pretrial Orders ("PTOs") # 1, # 30, #35, # 37, #39 and #43 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). Destructive analytical testing of oil, dispersant or sediment samples may only be conducted in accordance with PTO # 37, paragraph 11, and PTO # 39, paragraph 11. Circumstances and procedures governing preservation and disposal of sample materials by the trustees must be set forth in a written protocol that is approved by the state or federal agency whose employees or contractors are in possession or control of such materials and must comply with the provisions of PTOs # 1, # 30, # 35, 37, #39 and #43.

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 any Trustee-related estimated costs, 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 Table Chart #1.

Field Survey Costs	Hrs/Days/Trips	Day/Hr Rate	Total
NOAA Labor (days):			
NOAA Chief Scientist	14	[redacted]	[redacted]

6 Plankton/Net handlers	14 x 6	[redacted]	[redacted]
TOTAL			**$161,000**

Budget Table Chart #2.

Vessel Costs	
Mobilization Costs	[redacted]
Vessel Costs	[redacted]
Entrix Contractor Costs	[redacted]
Total Vessel Costs	**$3,896,116**

Total Estimated Costs **$4,057,116**

Appendices

Appendix A. GRTS Survey Design (see footnote 3)
Appendix B. SEAMAP Historical Plankton Sampling Summary
Appendix C. NRDA MOCNESS Deployment Protocol
Appendix D. Acoustic Survey Protocol
Appendix E. SOPs for Offshore Plankton Sampling (see footnote 2)
Appendix F. Personnel
Appendix G. SEAMAP Sampling Protocol Manual
Appendix H. Offshore Plankton Characterization Survey Health and Safety Plan

Offshore Zooplankton and Ichthyoplankton Characterization Plan:
Deepwater Horizon Oil Spill
Plankton Cruise IV
June 17, 2013

Cruise dates: October 15 – 28, 2010 (14 days)

Approvals

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

BP Approval	Joyce Miley Printed Name	Joyce Miley Signature	7/10/2013 Date
Federal Trustee Approval	Daniel Hahn Printed Name	[signature] Signature	7/9/13 Date
Louisiana Approval	KAROLIEN DEBUSSCHERE Printed Name	[signature] Signature	7/25/13 Date