Mississippi Canyon 252 Incident

NRDA Sampling Plan

# Quantifying the Distribution, Abundance and Biodiversity of Benthic Megafauna and Mesopelagic/Bathypelagic Megaplankton in the Vicinity of the MC252 Spill

Deepwater Benthic Communities Technical Working Group/Water Column Technical Working Group

**Final: June 8, 2011**

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.

**APPROVED:**

Department of Commerce Trustee Representative: 6/20/2011 Date

Louisiana Representative: 10/17/2011 Date

BP Representative: 10/10/2011 Date

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## Final: June 8, 2011

**Tentative Cruise Dates: June 8 – 22, 2011**

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## 1.0 Background and Objectives

### 1.1 Background

The MC252 oil spill incident introduced liquid and gaseous hydrocarbons, as well as dispersants, drilling muds, methanol, prolonged vehicle and sonar use, and debris into the Gulf of Mexico. Oil was released from several point sources located in the upper bathypelagic zone (from ~1544 m). Megafauna in the water column and on the seafloor in the vicinity of the potential oil pathways have not been previously targeted for assessment. Megafauna are organisms large enough to be detected in images (>~1 centimeter in length) or collected with a trawl (Gage and Tyler, 1991). These organisms are important components of deep sea communities. The biomass of water column and benthic megafauna can equal that of the smaller benthic macrofauna and since many are predators or scavengers, they play a critical role in community structure (Haedrich and Rowe, 1977). They are capable of substantial bioturbation and play a role in carbon cycling in the deep sea (Kaufmann and Smith, 1997). An understanding of the taxonomic composition and densities of benthic, demersal and mesopelagic/bathypelagic megafauna following the oil spill can potentially aid the injury assessment process.

Existing NRDA benthic studies have examined megafauna opportunistically, using sediment cores, and using ROVs. These programs are not specifically focused on megafaunal organisms outside of those collected within the sediment cores and those organisms associated with deepwater coral communities. Many of the megaplanktonic organisms in the mesopelagic and upper bathypelagic waters are gelatinous (siphonphores, ctenophores, salps, pyrosomes, appendicularians). The current NRDA Plankton Studies employ nets and imaging systems to quantify planktonic and micronektonic organisms. The MOCNESS net system does not provide quantitative estimates of many of the fragile gelatinous taxa due to extrusion and damage in the net. With the exception of the Digital-Automatic Video Plankton Recorder (DAVPR), most plankton imaging systems are configured to sample waters shallower than 200m and so deeper megaplankton densities cannot be quantified using these devices. While the DAVPR provides an image of intact gelatinous organisms, its field of view is smaller than that needed to quantify megafaunal plankton and small nekton, as it is designed to sample mesoplanktonic organisms. Thus, there is value in quantifying the distribution and biodiversity of megaplanktonic organisms with the ROV-based approach described herein, as some of these organisms are not well sampled by the nets or imaged by the DAVPR.

In 2010 and 2011, three separate Response-led ROV surveys were conducted in the vicinity of the MC252 wellhead to characterize benthic/demersal megafauna on the seafloor and megaplankton in the water column outside of the NRDA framework[1]. These surveys were conducted aboard the MV Olympic Challenger, the Development Driller II (DD2), and the Development Driller III (DD3). The Olympic Challenger was deployed during August 2010 to conduct ROV surveys of biological conditions in the water column and on the seafloor at five sites. Surveys were conducted at four sites located 2000 meters from the Macondo wellhead blowout preventer (BOP) at bearings of 0° (N), 90° (E), 180° (S), and 270° (W). A fifth site located 500 meters due north of the BOP was also surveyed.

The water column surveys and seafloor surveys followed protocols comparable to those summarized in Attachment A. Water column surveys were comprised of a set of 250 meter long horizontal video transects separated by vertical intervals of ~150 meters (500 feet) between 150 and 1500 m. Seafloor surveys utilized a radial transect design adapted from the Bureau of Ocean Energy Management, Regulation and Enforcement (BOEMRE) pre-bottom biological surveys (BOEMRE 2008). A series of 250 meter–long video transects beginning at a central origin and flown on headings separated by 15° were conducted by ROVs flying just above the seafloor. See Attachment B for details of the seafloor survey methodology.

A second series of Response-led ROV surveys of the water column and seafloor were conducted by the ROVs aboard the DD2 from early-August through early-November 2010 around the Relief Well #2. These surveys were performed at approximately weekly intervals and followed the protocols comparable to those described in Attachments A and B (note: navigation data were apparently not logged for these surveys).

In March 2011, the DD3 was deployed to conduct follow-on Response led surveys at sites around the Macondo BOP. This work was coordinated by and conducted through BP's Science

[1] Refer to the draft NRDA study plan *Analysis of Existing Photographic Data to Quantify the Observed Distribution, Abundance and Biodiversity of Benthic Megafauna and Mesopelagic/Bathypelagic Megaplankton in the Vicinity of the MC252 Spill* ("Consolidated Analysis Plan") provided to the Trustees May 17, 2011 for a full description of these studies.

and Technology Group in the Gulf Coast Restoration Office. The sites surveyed were: (1) MC252 Relief Well #2; (2) the site 2000 meters due North of the Macondo BOP; (3) the site 2000 meters due West of the Macondo BOP; and (4) a site in MC208 (approximately 3.3 kilometers north of the Macondo BOP) where the BP "Abandonment AUV Survey"[2] performed a photomosaic survey using an AUV in April 2011. These surveys employed the same protocols that were used for the previous surveys conducted by the DD2 and Olympic Challenger (see Attachments A and B for a summary of comparable methods). Both water column and seafloor surveys were performed using an ROV equipped with HD Video (1080P), SD Video (480P), an 8 megapixel digital still camera, laser scalers, and a subsea navigation system (Ultra Short Base Line "USBL").

During the Response, the surveys conducted by the Olympic Challenger, and DD2 followed by the 2011 DD3 surveys characterized the conditions on the seabed at close range to the spill origin. They helped to establish the observable biodiversity, observable abundance, and observable distribution patterns of megafauna and macroplankton shortly after the capping of the well. Moreover, they are closer in time and space to the BOP and the spill than any other known biological surveys focused on the seafloor, with the exception of the sediment coring studies whose primary objective was chemical characterization of the sediments and deepwater infaunal communities. Thus, the August ROV surveys provide the earliest record of conditions in the mesopelagic and near/on the seafloor within 2 km of the BOP for benthic, demersal and water column megafaunal communities. Moreover, the follow-on surveys conducted during the fall of 2010 and in March 2011, potentially provide data on how the observable distribution and observable abundances of organisms changed at those sample sites within a timeframe of six months or less.

As the Trustees were not party to the MV Olympic Challenger, the Development Driller II (DD2), and the Development Driller III (DD3) Response-led ROV surveys mentioned above and have not had an opportunity to review data from those surveys, signing this work plan does not constitute endorsement of the protocols, survey designs, reliability of data from these surveys, or the suitability of collected data from these Response-led ROV surveys for any comparisons made with data acquired as part of this work plan. All metadata from these previous studies will be provided to the Trustees by September 30, 2011 under the proposed NRDA Consolidated Analysis Plan that is currently under review by the Trustees (draft provided May 17, 2011).

## 1.2 Objectives

This document describes a plan to conduct surveys of megafauna that include revisits to sites sampled in August 2010, which may help quantify how the biological conditions (in terms of megafauna) have changed around the spill site following capping of the well. This program will provide data with the potential to quantify the biodiversity, distribution, and abundance of

[2] As part of the abandonment of the MC252 wellhead, BP was required by BOEMRE to survey the "abandonment area" around the wellhead. Data from this survey have been provided to the Trustees in collaboration with the cooperative NRDA Hardground AUV Survey conducted by the Deepwater Benthic Communities TWG.

benthic and demersal megafauna that are observable and identifiable from video and still photography on the seafloor at selected locations around MC252. In this plan it is understood that estimates of biodiversity, distribution, and abundance are all restricted to organisms that are observable with the cameras. As a secondary objective, the data necessary to estimate biodiversity and relative abundance of megaplanktonic organisms larger than 2.5 centimeters in diameter will also be collected. This program will conduct a single examination of selected sites in close proximity to, and further away from the Macondo BOP. The surveys will be performed during a cruise spanning June 8 – 22, 2011. Should additional follow-on surveys be of potential benefit based on the examination of the data collected during this program, then an additional plan may be considered.

# 2.0 Study Plan

## 2.1 Study Sites

Ten sites will be surveyed (Table I) with the potential addition of an eleventh site should time permit. These include sites in close proximity (<4 km) of the Macondo BOP as well as more distant sites that may or may not have been impacted by the spill. Four of these (#1-4) were previously surveyed by the Olympic Challenger during August 2010. Two of these four (the sites 2000 meters North and 2000 meters West of the Macondo BOP) were again surveyed by the DD3 ROV in March 2011. One site (MC252 Well #2) was surveyed by the ROVs on the DD2 at approximately weekly intervals from August to November 2010 and again by the DD3 ROV in March 2011. The final site (approximately 3.3 kilometers north of the BOP) is located in MC208 that had been sampled with a megacorer during the Response and where the BP "Abandonment AUV Survey" was performed in April 2011. With the exception of the MC208 site, these sites (Table I, Figure 1) are located within a 2000 meter radius of the BOP. In addition, four other more distant sites (with one more should time permit) are proposed. These sites were chosen after consideration of historic sampling and other data collected during the NRDA. Selected sites (1-11) are shown in Figure 1 and all are listed in Table I.

**Table I.** Proposed study site locations.

| Site | Description | Latitude | Longitude | Depth (m) |
|---|---|---|---|---|
| 1 | 2000 m North of BOP | [redacted] | [redacted] | 1473 |
| 2 | 2000 m West of BOP/ MC252 Photomosaic | [redacted] | [redacted] | 1521 |
| 3 | 2000 m South of BOP | [redacted] | [redacted] | 1612 |
| 4 | 2000 m East of BOP | [redacted] | [redacted] | 1577 |
| 5 | MC252 Well #2 | [redacted] | [redacted] | 1578 |
| 6 | MC208 Photomosaic | [redacted] | [redacted] | 1450 |
| 7 | Red crab 1D | [redacted] | [redacted] | 1043 |
| 8 | Red crab 1C | [redacted] | [redacted] | 860 |
| 9 | WSW Megafauna1 | [redacted] | [redacted] | 1043 |
| 10 | WSW Megafauna2 | [redacted] | [redacted] | 1044 |
| 11 (if time permits) | Red crab 6E | [redacted] | [redacted] | 1043 |

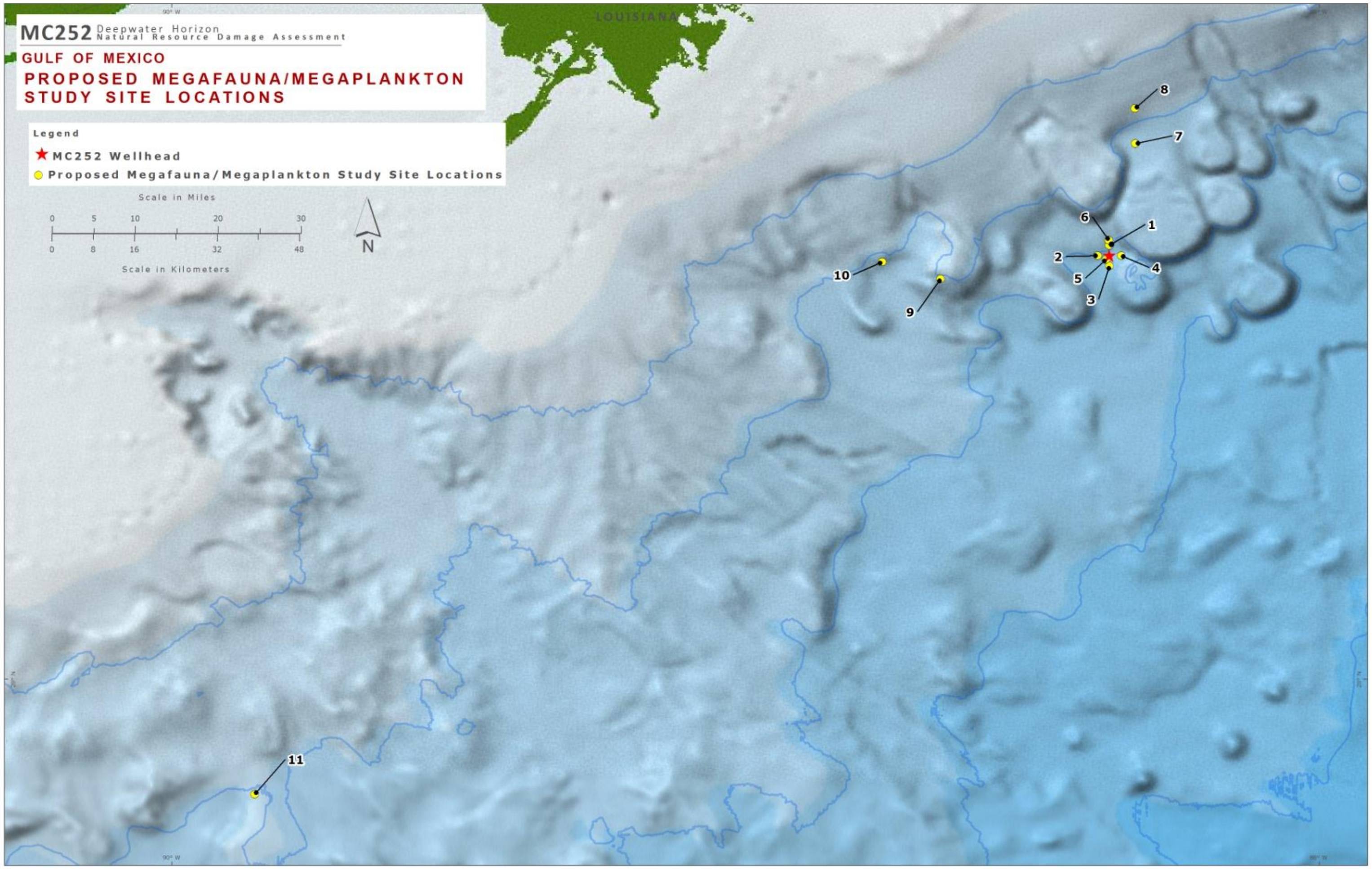


**Figure 1**. Locations of the proposed survey sites (☉) for the June Megafaunal cruise. See Table I for coordinates. Inset box on lower right: map showing the locations of the sites located in close proximity to the Macondo BOP.

## 2.2 Approach

*Seafloor Surveys*

Video or photographic transects are standard techniques for surveying benthic macrofauna (Rees and Service, 1993). Whether conducted using drift-cameras (e.g. Piepenburg and Schmid, 1997), manned submersibles (e.g. Felley et al. 2007) or ROVs (e.g. Hughes et al. 2010), these techniques permit direct observation of organisms in their habitat with little mechanical disturbance. Moreover, video surveys enable greater coverage of the habitat than grab sampling devices – an important factor given the generally low, and often patchy distribution of macrofauna. Also the video technique provides spatial location information along the transects, whereas trawls integrate all organisms collected over the length of the tow. Recognizing that all sampling approaches may introduce biases, such as due to behavioral changes related to lighting, noise or pressure waves and incomplete sampling, the specific deployment methods and data collected by the ROV sampling will need to be reviewed carefully to correct for or at least recognize any such biases.

The survey design is based on an enhancement of the BOEMRE visual habitat surveys (BOEMRE, 2008; see also Attachment B). The BOEMRE survey design consists of six, radial transects of at least 100 meters in length, oriented on bearings separated by 60° conducted by an ROV flying just above the seafloor. During the Olympic Challenger and DD2 surveys, this design was modified to provide more intensive spatial coverage by reducing the angle between bearings to 15° and extending the transect lengths to 250 meters (Figure 2).

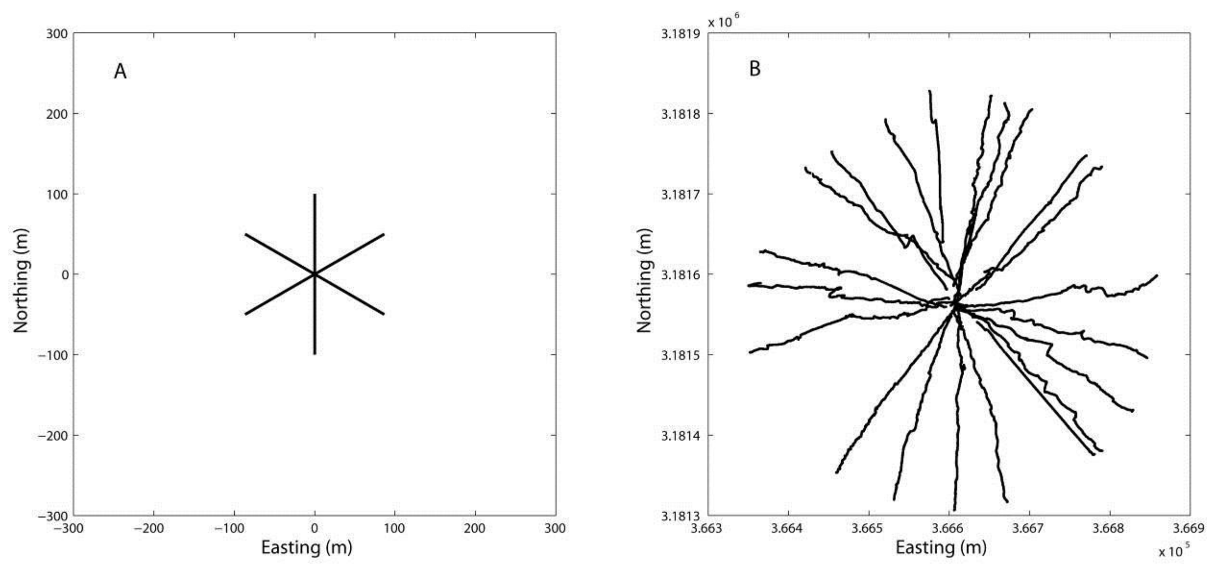


**Figure 2.** A. General design of the BOEMRE visual habitat survey. Each 100 meter long transect is conducted on a bearings separated by 60°. B: Actual survey conducted in August 2010 by an Olympic Challenger ROV at a site 2000 meters due north of the BOP. Survey legs were designed to be run on 250 meter long transects separated by 15°. Two transects were omitted from this survey due to time constraints. For the proposed study, transects will be separated by 15°.

Seafloor surveys will be flown using the above-described sampling design and protocols described in Attachment B at each site. Thus for the sites located 2000 meters north, west, south and east of the Macondo BOP, and at the MC252#2 and MC208 sites, a total of 24 250 m-long transects will be run in a radial design centered on each site. In addition, 250 m-long transects, with the same sampling design, will be run at the four other more distant sites (#7-10, with one more, #11, should time permit).

The ROV will fly at an altitude of approximately 1-2 meters above the seafloor with the HD video camera providing a wide-field view of the water and seafloor ahead of the vehicle. The precise altitude will depend on an initial assessment of the intensity of the lighting from the ROV and the water clarity, and the lighting will be held constant across all sites as much as possible given prevailing environmental conditions. The width of the field of view will be estimated using the spots from reference lasers (see Fig. 4) that are separated by a known distance. If the altitude has to be adjusted the parallel lasers will enable the field of view to be corrected. High-resolution digital still images of each megafaunal organism encountered will be obtained using the Imecon 12 megapixel still camera; however, during the outbound transects, the path of the ROV will not be altered to obtain the still images.

*Water Column Surveys*

The water column contains a variety of megaplanktonic organisms that can be readily enumerated via an ROV survey. The ROV must travel through the entire water column in order to reach the seabed and therefore must transit through the epipelagic, mesopelagic, and upper bathypelagic zones where a diverse assemblage of planktonic and micronektonic animals occur. Some of these organisms include pyrosomes (*Pyrosoma atlanticum* and *P. spinosum*), salps and salp houses occupied by the amphipod *Phronima*, whose mortalities have been documented during the spill. Other organisms constitute fragile gelatinous taxa (Figure 3) such as ctenophores, medusae, siphonophores, doliolids, and larvaceans, which may be damaged during sampling by nets and trawls. Thus, these organisms represent a substantial component of the mesopelagic and upper bathypelagic biomass that may not be well quantified by other types of sampling systems.

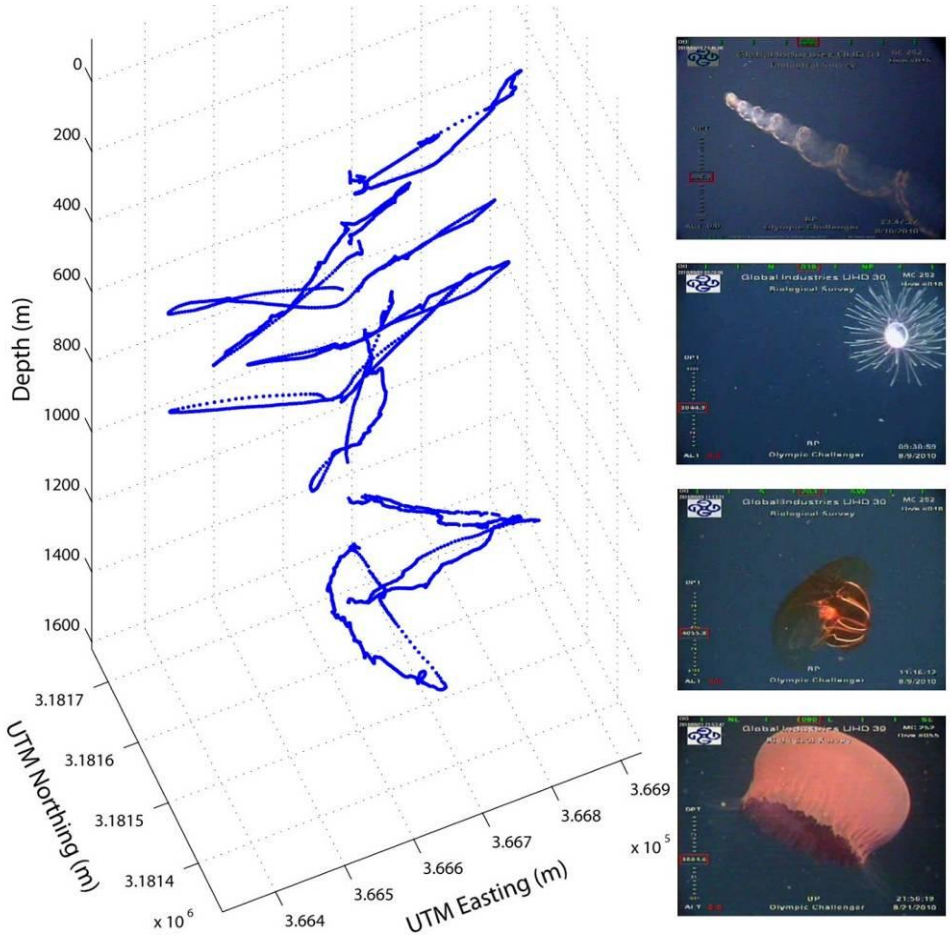


**Figure 3.** The trajectory of an Olympic Challenger ROV during a series of water column transects over the site located 2000 meters due North of the BOP. The purpose of this figure is twofold: (1) to demonstrate that the ROV position can be tracked in the water column; and (2) to illustrate some of the types of organisms that this plan will attempt to quantify. At each depth, the direction of the ROV was shifted to ensure that the prevailing current was carrying particles and organisms either directly toward, or from behind the ROV. In some cases the heading changed during a transect due to operator error or because the ROV deviated from the transect to obtain adequate footage of an organism. With an HD Video-equipped ROV, the time required to obtain adequate quality images should be briefer and deviations from planned transects will not be performed to pursue organisms of interest during the outbound transects. Quantitative surveys flow by the ROV in this plan will only be done in the direction of the prevailing current on a constant heading and at a constant depth (within the normal bounds of vehicle control). Images on the right illustrate some of the types of organisms encountered by the ROVs during water column surveys (top – bottom: salp chain *Helicosalpa virgula*, medusa *Crossota* sp., ctenophore *Lampocteis cruentiventer*, medusa *Poralia rufescens*).

Water column surveys will incorporate optical reference scales and measurements of the velocity of the ROV through the water to quantify the numbers of organisms observed per unit volume of water. The ROV will include optical reference points in front of the vehicle that will allow the width and height of the surveyed water in front of the vehicle to be defined. These reference points will be provided by a pair of parallel, down-looking lasers mounted on either side of the front of the vehicle on struts that extend forward of the ROV. They provide two parallel beams that project downward through the field of view of the HD video camera. Their lateral distance will be known, which will also permit the vertical distance observed by the camera to be determined. Only organisms passing through this identified area (effectively a quadrat) will be counted. A 1200 kHz downlooking ADCP will be mounted on the ROV. This will provide an estimate of the velocity of the vehicle through the water. Thus, the product of the survey time and the velocity from the mean of the ADCP bins nearest to the vehicle provides an estimate of the distance travelled by the ROV. By combining this information with ADCP data on the velocity of the ROV relative to the water, the volume surveyed will be estimated. The approach proposed here is an optical modification of a methodology first described by Bergström et al. (1987). That study placed a pair of vertical reference rods separated by 0.75m in front of the camera of an ROV. Using that approach and a flow-meter, they were able to estimate the densities of mesopelagic pandalid shrimp with high repeatability. Our approach will replace the rods with two green lasers oriented downwards and separated by the width of the ROV (~1.5-2.0 m). The lasers are located approximately 75 centimeters in front of the ROV. The 1200 kHz ADCP will replace the flow-meter that Bergström et al. (1987) employed.

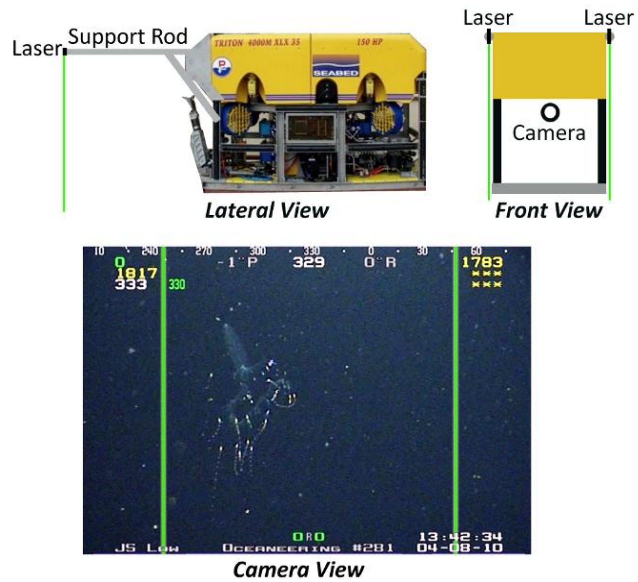


**Figure 4**. An example of how a pair of green lasers will be used to enable estimation of the area of water imaged in front of the ROV. When combined with a downlooking ADCP (not shown), the volume of water surveyed can be estimated. Organisms that pass between the lasers will be counted.

For each transect the ROV will be oriented so that the prevailing current is from directly behind the vehicle. The ROV will be put on to autoheading and autodepth and flown forward at a velocity sufficient for the vehicle to advance through the particle field without moving so rapidly as to make identification of the organisms in the HD video difficulty (limit motion blur). The vehicle will be flown forward for approximately 250 meters using the USBL navigation system to estimate distance travelled. Only animals passing between the lasers within the vertical extent of the field of view will be counted. These surveys will enable animal densities (number per cubic meter) to be estimated by dividing total numbers of each taxon passing through between the laser beams by the product of the frontal area and the distance traveled relative to the water (Figure 4). Once the ROV has completed the survey transect, it will fly back to the TMS and attempt to obtain high-resolution images of organisms using the Imenco 12 megapixel still camera. These images will facilitate subsequent identification of organisms that are present at that depth using a camera with superior resolution to the HD video camera. Any other animals detected within each stratum that did not pass through the surveyed volume will be recorded in a separate count. These additional observations that fall outside of our ‘optical net’, will provide a larger sample size for estimation of vertical distributions and may provide information for evaluation of potential avoidance of the sampled volume.

The water column surveys will provide the raw data that can potentially be used to estimate densities of gelatinous megaplankton in the water column. The cruise plan initially budgets enough time to permit a pair of water column surveys at sites 1 – 9. One water column survey will be performed during the day and another will be conducted at night. These surveys will not be performed during twilight hours (i.e. approximately between 05:00 – 07:00 and 17:00 – 20:30) to avoid periods when the majority of diel vertical migrators are moving. These times were estimated by digitizing echograms from the ADCP on VK936 for the last week of May, 2011.

Horizontal transects will be flown from 150 meter to 1500 meter at intervals of 150 meters (i.e., at 150, 300, 450, 600, 750, 900, 1050, 1200, 1350, and 1500m). Note that these transect depths encompass the majority of the depth range sampled by the 1 square meter and 10 square meter MOCNESS samples in the on-going surveys aboard the Nick Skansi and Meg Skansi. Each transect will be approximately 250 meters long flown with the prevailing current (i.e., down current) in order to reduce the encounter rate with organisms from other approaches and allow more time for sampling to improve identification. These surveys will be conducted once during the day and again after dark – so that changes in observed distributions due to diel vertical migration can be quantified. With this approach, the ROV will collect four daytime surveys and four nighttime surveys at each depth and location. The presence of a subsea navigation system will enable the position of the ROV to be estimated along each transect (e.g. Figure 3). See Attachment A for details of the survey methodology.

*ROV Configuration*

The position of the ROV will be measured and recorded using a subsea navigation system. During the August Olympic Challenger surveys, a USBL system was effective. Consequently, a USBL navigation is proposed for this work. Depth data are also required and these will be provided by the ROV pressure sensor. Navigation data will be saved as an ASCII text file with the fields: date (yyyy, mm, dd), time (hh,mm,ss.sss), depth, easting, northing, latitude, and longitude. Once the navigational data have been imported into Matlab, smoothing and interpolation algorithms can be used to reduce variation among successive position estimates and to reduce the interval between successive position estimates. For example, the Olympic Challenger surveys provided navigation fixes at intervals of 7 seconds on average. These were screened for outliers, smoothed with a 9 point running mean filter, and then linearly interpolated on to a 1 second time base. The same approach is proposed.

At least two cameras are required to conduct the surveys effectively. One camera, which will be a high-definition video camera (1920 x 1080i), is mounted on the lower pan and tilt unit. It is aimed directly ahead (during water column surveys) and downward at a shallow angle (during seafloor surveys) to provide a view of seabed ahead of the vehicle (e.g. Figure 5). A second camera, mounted on the upper pan and tilt is used to acquire close up images of megafauna (Figure 5). This camera will be a digital still camera with a minimum resolution of 12 megapixels. The digital still camera will have remote focus, zoom (10X or higher), and exposure control; and will be coupled to a high-intensity xenon strobe mounted on the ROV so that even illumination of the seafloor directly ahead of and downward from the vehicle can be achieved. The strobe will be mounted so that it is laterally separated from the still camera in order to prevent illuminating sediment and marine snow particles in the water in front of the camera. Lighting on the ROV will be high intensity daylight (HID) or daylight LED arrays with at least 2000 west of aggregate lighting capacity. Orientation of lights is critical and will require some preliminary dives to ensure that lighting geometry is optimal. Once optimal lighting has been established for the water column and the seafloor surveys (and they will likely differ), we will attempt to keep those lighting parameters constant for all of their respective surveys (unless necessitated by dramatic changes in water column conditions).

A second essential requirement is the ability to quantify the field of view that is being imaged. A pair of parallel laser scalers mounted on the lower pan and tilted above the still or HD video camera provides this capability. The lasers project spots of light separated by a known distance (currently 17 centimeters). This enables the sizes of organisms to be estimated (e.g. Figure 5 Upper). The pair of green lasers that is used as an optical reference during the water column surveys will provide a better estimate of the width of the seafloor being surveyed than the more closely-spaced laser scalers on the pan and tilt mount. When the field of view is known, it can be multiplied by the transect length to estimate the area of seafloor that has been surveyed. All video and digital still image data (including metadata) will be provided to all parties (Trustees and RP) as described in the data section below.

# 3.0 Data Handling/Data Sharing Process

## 3.1 Digital and Shipboard Data

Each survey will produce: (1) standard definition video files of the field of view in front of the ROV stored on DVDs; (2) high definition video; and (3) megapixel still images containing close-ups of organisms observed during the surveys; and (4) navigation data in ASCII format containing time, northing, easting, depth, latitude and longitude (sequence and format may vary from system to system). HD video data will be stored on 3.5” internal hard drives that are recorded to removable hard drive bays.

All data and imagery (including navigation, video files, instrument data, field logs, photographs and photo logs, and documentation), and other electronic data will be saved to an on-board computer, and all data shall be migrated to dedicated external hard drives. The data will be controlled and managed by the NOAA NRDA data manager under project protocols, including Chain-of-Custody tracking of the external hard-drives. Identical copies of the external hard drive will be created on the vessel. Upon return to port, the NOAA Data Manager shall deliver one of those copies each to NOAA (or its contractor), Louisiana Oil Spill Coordinator’s Office (LOSCO) on behalf of the State of Louisiana, and to Cardno ENTRIX on behalf of BP.

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.

Shipboard navigational data are an essential component of research cruises. GPS navigational data will be logged from the time the vessel leaves the dock until it returns at the end of the cruise. Given the criticality of matching data collected by the ROV with ship navigation data and ADCP data, all computer systems that are logging data will be synchronized with GPS time at the beginning of each watch. All shipboard navigational data will be migrated to dedicated external hard drives; and will be controlled and managed by the NOAA NRDA data manager under project protocols, including Chain-of-Custody tracking of the external hard-drives

### 3.2 Reporting

A cruise report will be submitted by the Chief Scientist within four weeks of the completion of the cruise, documenting the cruise activities and achievement of the cruise goals. This report will be provided to Trustee and RP representatives of the Water Column and Deepwater Communities TWG, as well as to the NOAA NRDA data manager. Daily reports will be provided by NOAA NRDA data managers and Cardno ENTRIX Project Scientists to Trustee and RP representatives, respectively during the cruise, documenting accomplished tasks, types of data sets collected, any difficulties encountered, any needed changes in the plans caused by weather or other factors, and projected activities for the following day.

### 3.3 Chain of Command

This cruise will be conducted under the direction of the Chief Scientist (Mark Benfield). The Chief Scientist is the sole point of contact with the Captain and the Bridge. When the Chief Scientist is not standing watch, his designated Watch Leader will have operational control over all matters relating to the scientific components of the cruise. No significant changes to the sampling protocol will be made without prior consultation with on-board Trustee representatives. The Captain has ultimate authority over his vessel and all matters relating to its safe operation. CSA personnel will deploy and recover equipment and do so in consultation with the Chief Scientist.

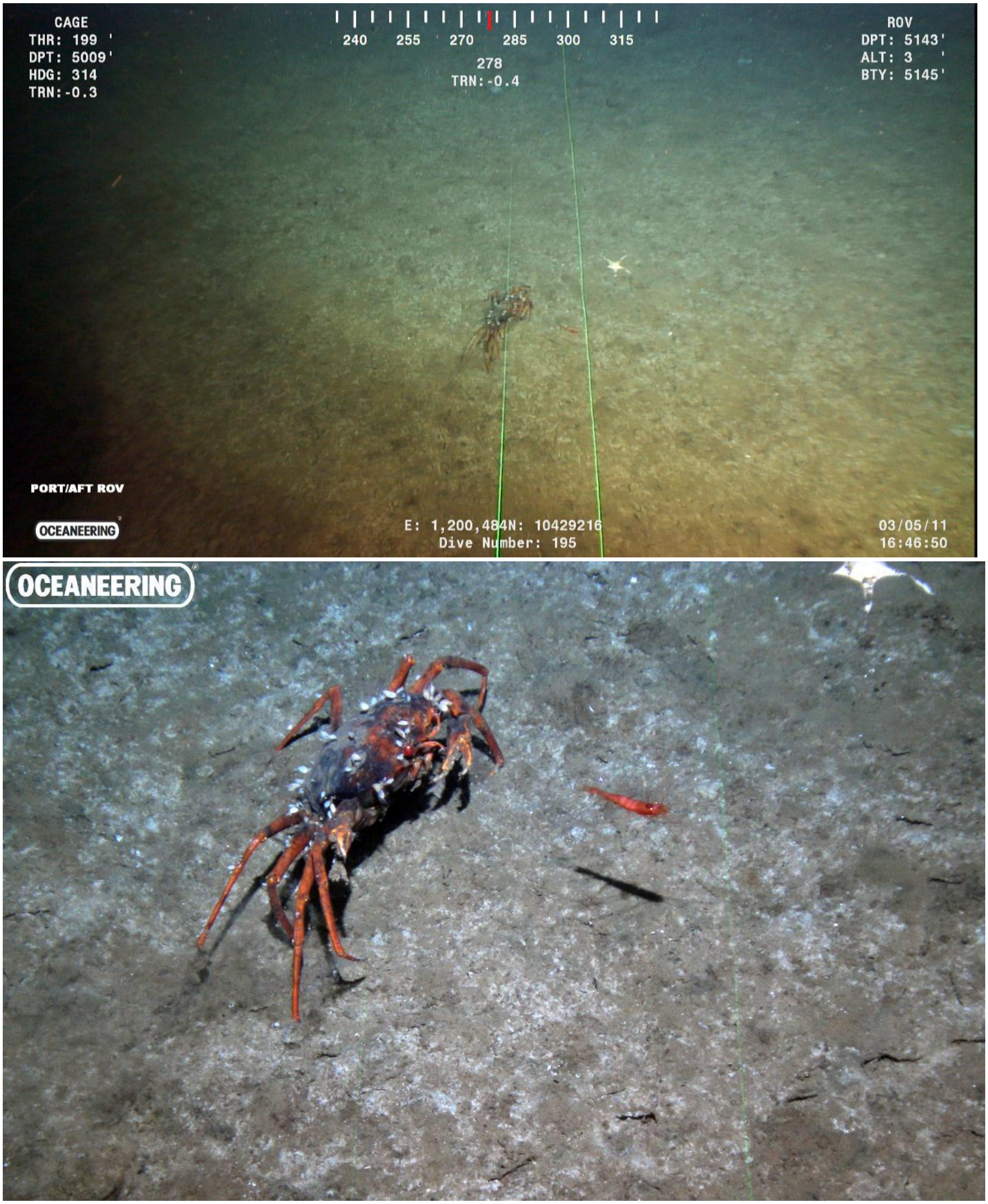


**Figure 5**. Top: A wide field view from a high definition video camera on the Oceaneering ROV deployed from the Development Driller 3 during March 2011. The green lines are from laser scalers that are 24 centimeters apart. Bottom: A close-up of a crab (*Chaceon* sp.), shrimp, and partial view of a seastar obtained using an digital still camera mounted on a pan and tilt bracket. The two images were acquired at the same time.

# 4.0 Logistics

## 4.1 Cruise Schedule

The cruise will depart Port Fourchon on June 8 and return June 22, 2010. The estimated schedule is summarized in Figure 6. This plan is based on the assumption that water column surveys will initially take 1 hour per depth because the pilots will have to become familiar with the demands of flying these surveys. Experience working with industrial ROV pilots indicates that it takes several hours of practice to become proficient with these surveys. Therefore, the time estimate for the completion of the first set of water column surveys is 10 h. Thereafter, fewer hours may be required to complete each of the surveys.

No weather days have been explicitly factored into the cruise plan; however, should additional time be available due to early completion of the surveys at sites 1 – 10, then site 11 will be surveyed if conditions are workable. Local sunrise ranges from 05:55 (6/9) to 05:56 (6/21) and sunset ranges from 19:51 (6/9) to 19:59 (6/21) based on the US Naval Observatory Calculator (http://aa.usno.navy.mil/data/docs/RS_OneDay.php) for a location at 28° 44'N, 88° 22'W. Based on these times, darkness should occur by 20:18 (6/9) to 20:22 (6/21). For the purposes of defining when night samples and day samples should occur, night samples will be collected between 20:30 and 05:00, while day samples will be collected between 07:30 and 17:00.

## 4.2 Personnel

4 ROV support personnel (2 pilots and 2 electronic/mechanical technicians)
4 CSA Personnel (2 winch operators, 2 deckhands); included in vessel costs
2 CSA Navigation Personnel (required to log both vessel and ROV positions)
1 LSU Chief Scientist
1 LSU Technician/Watch Leader
2 LSU Graduate Students
1 Cardno ENTRIX Data Manager/Field Technician
1 Cardno ENTRIX Project Scientist
2 NOAA Data Managers
2 Trustee scientists/representatives

## 4.3 Vessels

The M/V HOS Sweetwater is a vessel in the NRDA fleet that is available and is equipped to conduct the proposed sampling. Costs herein are based on use of that vessel. Actual vessel assignments and associated costs and schedules may be revised following review by Trustees and the Vessel Coordination Committee.

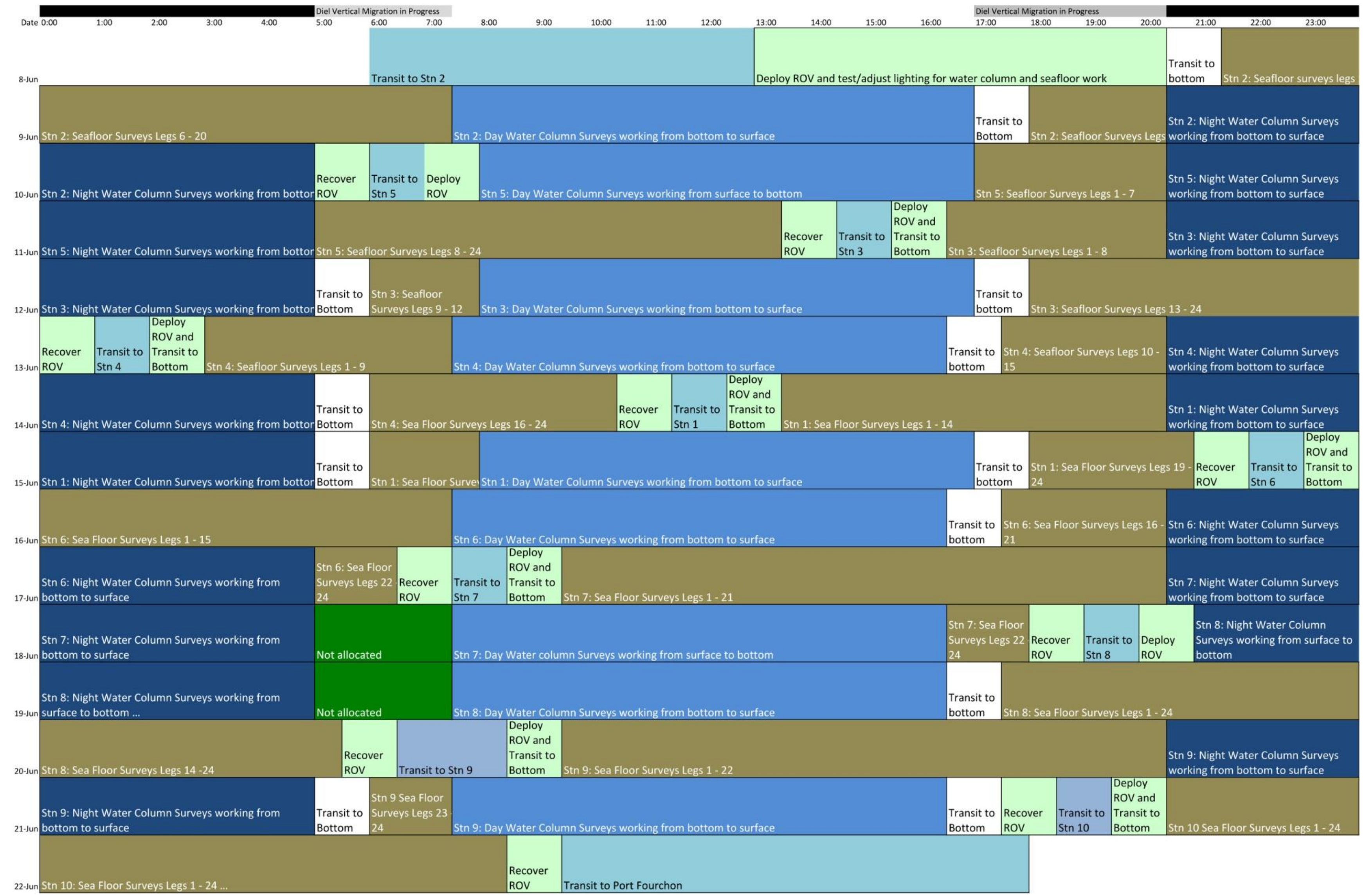


**Figure 6.** Initial cruise activity plan. This plan will be revised each day to reflect actual progress.

### 4.4 Sampling Equipment

Sampling deployment gear allowing potential to sample at full ocean depths (to 2500 m) to be provided and mobilized by CSA: Seabird CTD with dissolved oxygen sensor and CDOM fluorometer

## 5.0 Safety Plans

BP full operations and safety plans are attached as appendices. A HASP binder containing all health and safety protocols is provided to each vessel. Attachment E describes the NOAA data management protocols. Attachment C 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.

## 6.0 Costs

*Estimated Budget*

The costs summarized below are associated with the collection of the ROV data collected during this project. NOAA’s costs are in Budget Chart #1. Costs for vessel charter and ROV time as well as LSU labor and equipment costs are included in Budget Chart #2. The project will require approximately 14 days of ship/ROV time for the survey as provided in Budget Chart #2.

The Parties acknowledge that this budget is an estimate, and that actual costs may prove to be higher. BP's commitment to fund the costs of this work includes any additional reasonable costs within the scope of this approved work plan that may arise. The Trustees will make a good faith effort to notify BP in advance of any such increased costs.

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 and LSU labor and equipment costs indicated in Budget Chart # 2 shall be paid directly by BP.

**Budget Chart #1 Trustee Labor**

| Field Survey Costs | Hrs/Days/Trips | Day/Hr Rate | Total |
|---|---|---|---|
| NOAA Labor (days): | | | |
| 2 NOAA scientists | 15 x 2 | $1,500 | $45,000 |
| 2 NOAA Data Managers | 15 x 2 | $1,500 | $45,000 |
| Travel | 4 | $10,000 | $10,000 |
| TOTAL | | | $100,000 |

Days/Trips based on 15 potential cruising days. Labor is estimated cost and hours.

**Budget Chart #2**

| Cruise Plan Cost Table | Total |
|---|---|
| LSU Personnel, supplies and equipment | $261,959 |
| Mobilization Costs | $283,500 |
| Vessel Costs | $3,626,478 |
| Fleet Mgmt / Shore Support | $420,000 |
| Total Estimated Cruise Cost | $4,591,937 |

**Total Costs: $4,691,937**

## 7.0 References


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# 8.0 List of Attachments

**Attachment A: Water Column Survey Methodology**

**Attachment B: MC252 ROV Bottom Survey Protocol**

**Attachment C: Protected Species Interaction Prevention Procedures (1 main & 4 annexes)**

**Attachment D: BP/Cardno ENTRIX Health and Safety Protocols**

**Attachment E: NRDA_Field_Sampler_Data_Management_Protocol**

## Attachment A: Water Column Survey Methodology

a. Deploy the ROV in the TMS and lower the TMS to an appropriate altitude above the target depth (150 meters if working from the surface).

b. Lock the TMS so that it is facing down-current (if no current is present, any direction is fine). Detach the ROV from the cage, pay out enough tether to allow the vehicle to descend to the target depth, and ensure that the ROV is oriented so that it faces down-current. Set the ROV to autoheading and lock in the down-current direction. Set the ROV to autodepth.

c. Set the thrusters to 25% power (use a higher level if you feel the current requires it).

d. Set the HD camera on the pan and tilt mount to full zoom out, focus on a point far ahead of the ROV, then gradually focus closer to ensure that the downlooking green lasers are visible. Aim the camera so that it is facing forward, and turn on the lights that have previously been selected for use during water column surveys.

e. Confirm with navigation that data are being recorded and that a stable position solution for the ROV has been acquired. Confirm that the ADCP is running and logging. Confirm with the lab that the HD video is being recorded and that the digital still camera is operational.

f. Fly the ROV forward at a constant speed that is sufficient for the vehicle to advance steadily through the particle field. Observe the organisms that are ahead of the vehicle, which pass between the left and right down-looking lasers. Pay out tether as necessary to avoid any drag on the vehicle.

g. Note the presence of any other recognizable organisms that pass within the field of view of the camera but which do not pass between the parallel down-looking lasers.

h. Continue the horizontal survey until navigation informs you that the ROV has traveled 250 meters from the TMS. Fly the ROV back to the TMS while continuing to observe for organisms. Maneuver the ROV to obtain close-ups and document any that you observe using video and stills.

i. Latch the ROV to the TMS and continue to the next depth stratum.

j. Repeat the survey at the next depth and continue until you have surveyed the last depth that is a multiple of 150 meters before encountering the seafloor.

# Attachment B: MC252 ROV Bottom Survey Protocol

Survey Geometry

The survey will be a more comprehensive version of the original MMS pattern. It will consist of 24 x 250 meters long transects flown outwards from the station coordinates at headings separated by 15° (Figure B1). Surveys should be flow at an altitude above the bottom of approximately 1-2 m, because the altitude should be high enough to allow a clear view of the seafloor without disturbing the sediment on the bottom. The survey velocity must be slow enough to be able to observe the seafloor ahead of the ROV and to allow the vehicle to slowly approach animals on the seafloor to obtain close-ups.

a. Lower the ROV in the TMS to an altitude over the seafloor of approximately 50 meters and position the TMS so that it is over the center point of the survey site.
b. Detach from the TMS and lower the ROV over the center point of the survey site until it is a few meters above the seafloor. Confirm with navigation that they are tracking the ROV and that it is in the correct location.
c. Adjust the lights so that the previously-determined configuration for optimum seafloor illumination is used. Confirm that HD video and SD video are being recorded. Make sure both the down-looking lasers and the parallel laser scalers are on and visible.
d. Lock in autoheading in the direction of the first transect (you will be provided with a sequence of transects).
e. Descend until the altitude is 1-2 meters above the seafloor. The exact altitude will depend on the water clarity.
f. Fly the ROV slowly forward and look for organisms. As the ROV approaches the organisms, use the digital still camera to obtain a few representative still images. Do not alter course while sampling outbound transects.
g. Continue to fly outwards along the transect until Navigation informs you that you have reached 250 m.
h. Ascend to clear the seafloor and return to the center point to repeat this sequence for the next transect.

Video and Still Image Recording

Video must be recorded continuously along each transect.

Take high-quality, representative still images of every organisms that you encounter. If organisms are moving too quickly to acquire a still image, use the HD video to obtain as clear an image as is possible. This is essential to assist with identification of organisms down to the lowest taxonomic level. A good quality megapixel digital stills camera equipped with zoom (10X optical or better), focus, and exposure control is required. The camera must have at least one xenon strobe to illuminate targets. Ideally the strobe should be positioned laterally from the camera to avoid illuminating suspended particles in the water column between the camera and the subject. Keep a log of each still image and its contents.

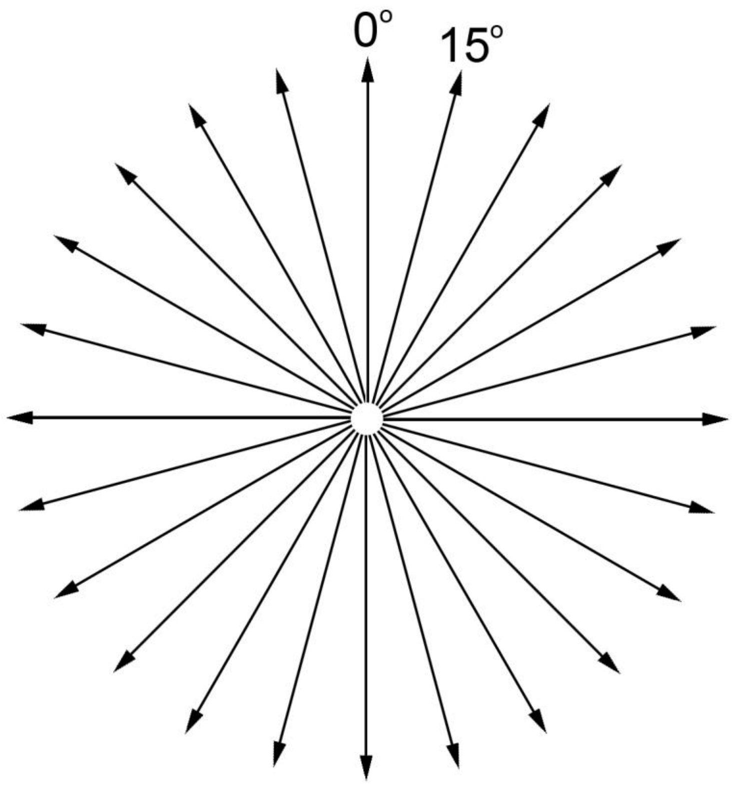


**Figure B1.** Geometry of the bottom survey. Each arrow begins as close to the center of the survey site as safety and operations permit. The arrows extend outwards from the survey center point along headings separated by 15° intervals..