Mississippi Canyon 252 Oil Spill

NRDA Tier 1 for Deepwater Communities-Addendum Plan for Coral Aging

Deepwater Benthic Communities (Deepwater Coral) Technical Working Group

December 16, 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.

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.

This plan will be implemented consistent with existing Trustee regulations and policies. All applicable state and Federal permits must be obtained prior to conducting work.

APPROVED:

Robert W. Ricker   Feb 2, 2012
Department of Commerce Trustee Representative: Date

FOR
ROLAND
GUIDRY

signature   4/13/2012
Louisiana Representative: Date

signature   2/6/2012
BP Representative: Date

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1. Introduction:

This plan addresses ageing of coral specimens collected on several National Science Foundation (NSF) and BP NRDA-funded deepwater assessment cruises. Below we present background information on the specimens, the objectives of performing this analysis, the methods to be employed, and other data sharing and budget information.

2. Background:

Information on growth-rates and life-spans of deep-sea corals is important for understanding the vulnerability of these organisms to both natural and anthropogenic perturbations, as well as the likely duration of any observed adverse impacts. Demonstrated slow growth-rates suggest that it may take centuries for certain deep-sea coral species to recover from negative impacts. Results from work outlined in this addendum will represent the first comprehensive investigation of growth-rates and age distributions of proteinaceous corals from the area of potential DWH impact.

Investigations conducted as part of the Bureau of Ocean Energy Management, Regulation, and Enforcement/National Oceanic and Atmospheric Administration Office of Ocean Exploration (BOEMRE/NOAA OER) Cruise aboard the NOAA Ship *Ron Brown*, from October 14th to November 4th, 2010, discovered a brown flocculent layer covering a hard bottom coral community located within Mississippi Canyon Block 294 (MC 294). *Paramuricea* sp. is the dominant coral species at this site. One *Paramuricea* specimen was collected at this site in November for age analysis. Follow-up studies continued investigations of these colonies, including additional collections for histopathology and age analysis. The studies included an *R/V Atlantis* cruise, funded by the National Science Foundation (NSF); and the NRDA *Deepwater ROV Sampling to Assess Potential Impacts to Hardbottom Coral Communities and Associates from the Deepwater Horizon Oil Spill* study conducted on the *Holiday Chouest*. This work plan outlines the ageing of corals collected as part of these NSF and NRDA efforts.

Recently published results from Prouty et al. (2011) indicate that deep-sea black corals (*Leiopathes* sp.), approximately 40-55 km north and northeast of the Deepwater Horizon oil spill, have been growing continuously for at least the last two millennia, with growth rates ranging from 8 to 22 μm yr^{-1}. However, there are no published values for growth rates or ages for *Paramuricea* sp. from the Gulf of Mexico, which is the dominant coral species at MC 294. Preliminary results from a single sample collected during the BOEMRE/NOAA OER *Ron Brown* Cruise suggest a *Paramuricea* specimen (GU2888-A1102-TE906) from the MC 294 site was at least 560 years old, with a growth rate of 6 μm yr^{-1}. The only other data published for

Paramuricea spp. is from the continental slopes of Newfoundland and Labrador (Sherwood and Edinger, 2009).[1]

In contrast to the calcium carbonate skeleton of *Lophelia* sp., the scleractinian framework reef building corals, the proteinaceous corals such as *Paramuricea* rely on a surface-derived food source (i.e., particulate organic carbon) rather than sedimentary or dissolved organic carbon (Druffel et al., 1995; Roark et al., 2006). As a result, the ^{14}C-derived age estimates of proteinaceous corals are assumed to be unaffected by feeding upon old resuspended sedimentary carbon because these organisms acquire their carbon from surface-water organic matter after rapid transport to depth (Roark et al., 2009)[2]. Therefore, robust ^{14}C-derived chronologies and known surface ocean ^{14}C reservoir age constraints in the Gulf of Mexico provide reliable calendar ages to the collection of proteinaceous corals.

3. Objectives:

The objective of this analysis plan is to use both "bomb" produced radiocarbon over the last approximately 60 years and conventional ^{14}C ages (based on the known radioactive decay rate) calibrated with reservoir corrections to calculate calendar ages, as well as growth rates for *Paramuricea* corals collected at MC 294 and other hard ground locations (see Exhibit 1, below) in the area of potential DWH impact. Results from work anticipated under this addendum will represent the first comprehensive investigation of growth-rates and age distributions of proteinaceous corals from MC294 and may provide the qualitative background to assess recovery times from potential MC 252 impacts. Specifically, the objective is to assess coral ages of four coral specimens collected in the Fall of 2010 and approximately 12 specimens collected on the NRDA cruise outlined in the NRDA Sampling Plan entitled *Deepwater ROV Sampling to Assess Potential Impacts to Hardbottom Coral Communities and Associates from the Deepwater Horizon Oil Spill*, conducted in October 2011.

4. Methods:

The methodology for preparing, radiocarbon dating, and determining age and growth rates for the coral samples is described in detail in Roark et al. (2005). This technique has been used successfully with proteinaceous black corals (*Leiopathes* sp.) collected in the Gulf of Mexico (Prouty et al., 2011). Similar radiocarbon aging techniques have been used successfully with the proteinaceous components of other gorgonian corals (Roark et al. 2005). A cross-sectional disc will be prepared from the base (trunk) of each coral specimen. A transect across this disc will be sampled and analyzed to include polyp, tissue layer, center (inner), middle and outer portions across the radial transects. Therefore each coral specimen will yield approximately 5 radiocarbon measurements which are needed to calculate the age and growth rate of a particular specimen. In addition, tips and polyps from the coral specimens will be analyzed in order to capture the radiocarbon signal in the most recently accreted material.

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[1] To date, the only published radial growth rates and age calculations for deep-sea *Paramuricea* sp. are from Sherwood and Edinger (2009) from the continental slope of Labrador and Newfoundland. They report growth rates for two deep-sea *Paramuricea* sp. specimens, 92±18 and 205±20 μm yr^{-1}, and bomb ^{14}C ages of 103±14 and 71±6 years, respectively.

[2] Feeding on old dead carbon may yield older ages than the actual age. However, there is currently little evidence suggesting that old dead carbon from the deep sea is a dominant carbon source to proteinaceous corals.

Each subsample, representing approximately 0.5 to 6 mg of skeletal and tissue material will be prepared for Accelerator Mass Spectrometry (AMS) radiocarbon (^{14}C) dating at the Keck Carbon Cycle AMS laboratory at UC Irvine (KCCAMS). Samples will be pretreated with a deionized (DI) water rinse three times and a weak hydrochloric acid (1 N) rinse, and then rinsed three times with DI. Excess liquid will be pipetted off prior to drying down. The carbon in the samples will be converted to CO_2 via sealed tubed combustion with silver and CuO, and upon cyrogenic purification the CO_2 will be reduced to graphite in the presence of iron catalyst and a stoichiometric excess of hydrogen. Process blanks will include a coral blank.

Radiocarbon results will be reported as □^{14}C (‰) and conventional radiocarbon age (CRA) after applying a □^{13}C correction (Stuiver and Polach, 1977). Analytical uncertainty is typically between 1.3-3.9 ‰ and age errors ranged between ±15-30 years. Conventional ^{14}C ages will be converted to calendar years using a reservoir correction of 240 ± 13 years (□R of -30 ± 26 ^{14}C years) based on pre-bomb surface water radiocarbon measurements derived from a coral record from the Flower Garden Banks, northern Gulf of Mexico (Wagner et al., 2009), and the Calib 6.0 radiocarbon calibration program. Both the reported radiocarbon and calibrated age uncertainties will be reported at the 1 sigma level.

4.1. Samples:
Four colonies of the proteinaceous coral *Paramuricea* sp. were collected from the field of potentially impacted corals located within Mississippi Canyon Block 294 (MC 294) between November 2 and December 10, 2010. Preliminary growth rate and ^{14}C-derived age results are reported above for GU2888-A1102-TE906. In addition, specimens from twelve colonies of proteinaceous corals occurring in the vicinity of the DWH spill site collected in October, 2011, on the *Holiday Chouest* will be sub-sampled for ageing. These include additional colonies of *Paramuricea* sp. and *Chrysogorgia* spp. species observed at MC 294, as well as from potentially-impacted and reference areas (see Exhibit 1 below).

Exhibit 1. Samples for analysis

Site	Sample ID	Species	Sample Date	Status[1]
MC338/294	HC3-B1003-T-E8-MC338/294001-C001	*Paramuricea spp.*	10/3/11	PLT
MC338/294	HC3-B1004-T-E8-MC338/294004-C001	*Paramuricea spp.*	10/4/11	PLT
MC297	HC3-B1005-T-E8-MC297001-C007	*Paramuricea spp.*	10/5/11	PLT
MC297	HC3-B1005-T-E8-MC297001-C008	*Paramuricea spp.*	10/5/11	PLT
MC297	HC3-B1006-T-E8-MC297002-C001	*Paramuricea spp.*	10/6/11	PLT
MC388	HC3-B1006-T-E8-MC388007-C006	*Paramuricea spp.*	10/6/11	DT
MC388	HC3-B1007-T-E8-MC388008-C001	*Paramuricea spp.*	10/7/11	PLT
AT357	HC3-B1011-T-E8-AT357010-C002	*Paramuricea spp.*	10/11/11	LT
AT357	HC3-B1012-T-E8-AT357011-C002	*Chrysogorgia spp.*	10/12/11	LT
MC036	HC3-B1015-T-E8-MC036017-C003	*Chrysogorgia spp.*	10/15/11	PLT
MC506/507	HC3-B1016-T-E8-MC506/507022-C001	*Paramuricea spp.*	10/16/11	DT
MC118	HC3-B1021-T-E8-MC118024-C001	*Paramuricea spp.*	10/21/11	PLT
MC294	GU2888-A1102-TE906	*Paramuricea spp.*	11/2/10	PLT
MC294	GU2888-A1209-TE301	*Paramuricea spp.*	12/9/10	PLT
MC294	GU2888-A1210-TE328	*Paramuricea spp.*	12/10/10	LT
MC294	GU2888-A1210-TE329	*Paramuricea spp.*	12/10/10	DT

[1] LT – Live tissue/polyps present over entire colony at time of collection
PLT – Live tissue/polyps present over a portion of the colony at time of collection, time of tissue/polyp loss unknown
DT – No apparent live tissue present at time of collection, time of colony death unknown

5. Data Sharing:

Coral aging analyses will be performed at Keck Carbon Cycle AMS (KCCAMS) facility at the *University of California Irvine* by N. Prouty. All data generated at KCCAMS by Dr. Prouty will be shared in accordance with the terms described below.

Each laboratory shall simultaneously deliver raw data, including all necessary metadata, generated as part of this work plan as a Laboratory Analytical Data Package (LADP) to the trustee Data Management Team (DMT), the Louisiana Oil Spill Coordinator's Office (LOSCO) on behalf of the State of Louisiana, and to BP (or Cardno ENTRIX on behalf of BP). The electronic data deliverable (EDD) spreadsheet with pre-validated analytical results, which is a component of the complete LADP, will also be delivered to the secure FTP drop box maintained by the Trustees' Data Management Team (DMT). Any preliminary data distributed to the DMT shall also be distributed to LOSCO and to BP (or Cardno ENTRIX on behalf of BP). Thereafter, the DMT will validate and perform quality assurance/quality control (QA/QC) procedures on the LADP consistent with the authorized Analytical Quality Assurance Plan, after which time the validated/QA/QC'd data shall be made available simultaneously to all trustees and BP (or Cardno ENTRIX on behalf of BP). Any questions raised on the validated/QA/QC results shall be handled per the procedures in the Analytical Quality Assurance Plan and the issue and results shall be distributed to all parties. In the interest of maintaining one consistent data set for use by all parties, only the validated/QA/QC'd data set released by the DMT shall be considered the consensus data set. In order to ensure reliability of the consensus data and full review by the

parties, no party shall publish consensus data until seven 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).

All materials associated with the collection or analysis of samples under these protocols or pursuant to any approved work plan, except those consumed as a consequence of the applicable sampling or analytical process, must be retained unless and until approval is given for their disposal in accordance with the retention requirements set forth in paragraph 14 of Pretrial Order # 1 (issued August 10, 2010) and any other applicable Court Orders governing tangible items that are or may be issued in MDL No. 2179 IN RE: Oil Spill by the Oil Rig "DEEPWATER HORIZON" (E.D. LA 2010). Such approval to dispose must be given in writing and by a person authorized to direct such action on behalf of the state or Federal agency whose employees or contractors are in possession or control of such materials. This plan will be implemented consistent with existing trustee regulations and policies. All applicable state and Federal permits must be obtained prior to conducting work.

6. Milestones and Deliverables:
A report of age analysis will be delivered within three months of final radiocarbon analysis. Summary data for radiocarbon analysis in the report will include unique sample identification (sample ID), laboratory identification (Lab ID), sample distance from outer edge ($\Box$m), fraction modern relative to standard, fraction modern error, $\Box^{14}$C value as defined in Stuiver & Polach (1977), $\Box^{14}$C error, number of age ranges based on number of intersections with calibration curve, minimum and maximum age range (cal. year BP) based on 1 sigma, relative area under distribution of the calibration curve, and radial growth rate calculated as the slope of the linear regression line of reservoir corrected ^{14}C age versus sample distance from the outer edge (μm).

7. Key Personnel:

- Dr. Nancy Prouty, USGS, coral aging analysis
- Dr. Amanda W.J. Demopoulos, USGS, Benthic ecology

8. Safety Plans:

All applicable lab safety protocols as outlined in the DOI Safety Guide (http://www.doi.gov/safetynet/training/sources/index.html) will be followed as part of the work associated with this plan.

9. Budget:

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.

Analytical	$14,100.00

*Radiocarbon analysis at $188 per sample

*The number of samples (5 per specimen) includes a sample from a polyp, tissue layer, center (inner), middle and outer portions across the radial transects. Number of specimens represent 12 additional new specimens to be collected in addition to 3 previously collected specimens in 2010.

Salary	
USGS Pacific Coastal and Marine Science Center Scientist (N. Prouty) 60 days @ $461.44/day	$27,686.40

*Represents ~4 days for preparation, analysis and data reduction per specimen (n=15)

subtotal	$41,786.40
USGS overhead rate 57.52%	$24,035.54
Total Project Budget	**$65,821.94**

10. References:

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