Status of the Deepwater Horizon Natural Resource Damage Assessment

Written Testimony of
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Testimony before the Senate Committee on Environment and Public Works
Subcommittee on Water and Wildlife
Washington, DC

July 28, 2011

Submitted on June 23, 2011

Attached please find the written testimony of Erik Rifkin, PhD.

QUANTIFYING CHRONIC DAMAGES TO NATURAL RESOURCES IN THE GULF RESULTING FROM THE BP SPILL:

AN INDEPENDENT STUDY

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June 28, 2011

PREFACE

Approximately one year ago (July 27, 2010), the National Aquarium was given the opportunity to provide the Senate Subcommittee on Water and Wildlife written and oral testimony at a hearing on "Assessing Natural Resource Damages Resulting from the BP *Deepwater Horizon* Disaster". At that time, we emphasized the importance of independent research when attempting to quantify potential chronic damages to natural resources in the Gulf resulting from exposure to petroleum from the BP spill. The rationale for this view was, and still is, based on the concern that the NRDA process is not using a methodological approach which adequately measures small quantities of petroleum contaminants which could have chronic impacts on aquatic biota.

More specifically, the National Aquarium's testimony, and the testimony of the other independent researchers on the panel, suggested that passive diffusers be used to measure low levels of petroleum in order to accurately characterize ecological risks. Since the last hearing, the National Aquarium Conservation Center (NACC), in collaboration with Mote Marine Laboratory and Johns Hopkins University, has conducted research designed to provide concerned government agencies and others with data necessary to quantify chronic damages to natural resources in the Gulf. The findings from this independently funded study will be readily available to interested parties, including Gulf communities directly impacted by this oil spill.

Our research involves the deployment of sophisticated petroleum contaminant samplers, developed by the USGS, called semi-permeable membrane devices (SPMDs). These devices function as "virtual" fish and provide unparalleled, time integrated data on levels of petroleum contaminants in the water column and sediment porewater (interstitial water found in sediment) necessary for assessing potential chronic impacts. Data will be integrated into bioconcentration and bioaccumulation

models in order to more clearly understand the fate and transport of petroleum contaminants in aquatic organisms.

By using SPMDs, we were able to obtain empirical data on levels of individual PAHs (organic pollutants found in petroleum) in the water column and porewater in areas impacted by the BP spill. Our findings support the contention that data obtained from SPMDs, when incorporated into bioconcentration models, will provide a far more accurate assessment of the nature and extent of chronic damages in the Gulf than the standard approach of collection and analysis of grab samples of water and sediment.

The ramifications of our findings should not be underestimated. The ability to measure levels of potentially toxic PAHs in the water column and sediment porewater at specific sites is a necessary prerequisite to accurately quantifying chronic damages to natural resources.

Following the July 27, 2010 Senate Subcommittee hearing, a meeting was arranged with representatives from EPA so that we could share our preliminary findings with the Agency and obtain advice and guidance from their research scientists. At our meeting and in subsequent discussions, EPA scientists supported the use of passive diffusers to monitor levels of PAHs in the water column, sediment and sediment porewater. They acknowledged the benefits of these devices to measure low concentrations of contaminants which, because of bioconcentration, could result in adverse impacts.

A meaningful NRDA must be able to incorporate robust data into economic models in order to accurately quantify chronic damages and injury to natural resources in the Gulf. In light of our findings, there are reasons to give serious consideration to expanding the use of passive diffusers in impacted areas of the Gulf as soon as possible. This will increase our ability to assess causality between the release of oil and injured resources and/or lost human use of those resources and services.

We look forward to the opportunity to provide you with an update of our findings.

I Goals and Objectives

This independent research involves the use of passive samplers to monitor PAH concentrations in water, sediment porewater and sediment in the Gulf of Mexico in order to quantify site-specific, chronic damages to natural resources. The research team consists of three institutions: the National Aquarium Conservation Center (NACC) (Baltimore, MD), Johns Hopkins University (Baltimore, MD) and Mote Marine Laboratory (Sarasota, FL.).

Our goal is to use passive samplers, such as semi-permeable membrane devices (SPMDs) and polyethylene (PE) tubing, to monitor the PAH concentrations in water and sediment porewater respectively, impacted by the *Deepwater Horizon* oil spill. These passive samplers are considered to be an innovative approach in measuring time integrated ng/L levels in situ.

The monitoring results will be archived and shared with all interested stakeholders, researchers and regulators. Our plans are to incorporate the measured values into mathematical models to study bioconcentration and bioaccumulation of PAHs in the Gulf of Mexico ecosystem impacted by the oil spill.

In addition, the measured PAH levels in water and sediment porewater can be used as base line concentrations, which will assist other researchers in conducting a variety of bioassays designed to assess the sublethal toxicity of PAHs and to generate new benchmarks for evaluating possible chronic damages.

II Summary Description of the Proposed Work

We propose a comprehensive approach to characterizing the existing petroleum (PAHs) levels in oil spill impacted areas in the Gulf of Mexico. We will collect data on petroleum levels (specifically focused on PAHs and their homologues) from the water column, sediment porewater, and sediments. In addition, sediment dwelling benthic organisms

which comprise the basis of the foodweb and commercially important organisms, such as redfish, shrimp, oysters, and finfish, will be collected and analyzed to measure bioaccumulated PAHs. The proposed monitoring study particularly suggests using passive samplers, such as semi-permeable membrane devices (SPMDs) and lipid free polyethylene (PE) tubing to measure time integrative PAHs in water and sediment porewater in-situ [1].

Although grab sampling has been traditionally used in this NRDA, that method of sampling provides information on the concentrations of PAHs only during one point in time or a relatively brief interval of time, which is in marked contrast to the exposure duration of most organisms. Moreover, grab sampling methods suffer from potential problems with sample preservation, and the method quantification limits are not adequate for the analysis of environmentally relevant (ng/L) levels of PAHs in water. These relatively low levels of quantification are especially needed for assessing the chronic damages to the natural resources in the Gulf of Mexico.

These difficulties can be minimized by using SPMDs and lipid free PE tubing which can provide a more time integrative measure and improve the ability to detect the low concentrations of PAHs in aqueous environments. The SPMD is one of the most studied and widely used passive sampler for determining water column concentrations [2], and the research team has experience and data sets on PAH occurrence from the use of SPMDs in the Gulf of Mexico, which were obtained with seed funding from the NACC.

SPMDs have severe limitations for measuring sediment porewater concentration, so lipid free PE tubing will also be used to better estimate porewater PAH concentrations [3, 4]. It is important to know sediment porewater PAH levels as they are a better indicator of the bioavailable fraction of PAHs than total sediment concentrations [5].

The passive samplers will be deployed in aquatic environments for several weeks, and PAHs will accumulate in the adsorbing materials of the devices. The samplers will be retrieved and be transported to the laboratory to extract and determine the accumulated PAHs using analytical instruments, such as GC-MS. The water and sediment porewater PAH concentrations can be estimated from the accumulated PAHs with strict QA/QC,

such as estimation of sampling rates using performance reference compounds (PRCs) and mathematical models considering ancillary parameters, such as temperature, dissolved organic carbon and salinity.

III The Value of the Obtained Data

After the Deepwater Horizon oil spill, one of the primary responses from federal and state regulatory agencies, for the natural resource damage assessment, has been collecting water and sediment grab samples and analyzing concentrations of PAHs. The water PAH levels have been directly compared to benchmarks, such as the final chronic value (FCV) derived from the National Water Quality Criteria (WQC) guidelines [6]. The PAH levels in sediment porewater were estimated from the sediment PAH concentrations using equilibrium partitioning theory (EqP) [7, 8]. These values were then compared to the benchmarks, assuming that porewater PAH values are the best estimate of toxicity and bioavailability. So far, most of the grab samples have revealed concentrations below the analytical detection limit, so the assumption is made that there are insignificant damages to the natural resources from the released PAHs [9].

However, PAH values below non-detect and predetermined benchmark values doesn't mean that PAHs are absent or present at levels which are not harmful. The benchmarks are meant to be used for screening purposes only. They are not regulatory standards, site-specific cleanup levels, or remediation goals, and only help the public understand the condition of the environment as it relates to the oil spill.

We have learned valuable lessons from the Exxon Valdez spill with regard to long-term effects on the populations of aquatic organisms [10]. Persistent effects of toxicant exposures were evident in certain species of fish and sea birds and in sea otters, with a notable and persistent decline in some species over the years due to increased mortality, lower growth rates, decreased reproduction and compromised immune function. We observed significant residual oil in the Barataria Bay (LA) from the oil spill during our recent field experiment in May 2011(see Figure 1).

For more accurate quantification of the chronic damages to the natural resources in the Gulf of Mexico, it is necessary to monitor the PAH levels in a more robust way rather than continuing to collect grab samples and reporting non-detect (ND) values. The data obtained from the passive samplers can be used in a variety of ways in quantifying chronic damages to the Gulf of Mexico ecosystems. For example, the bioaccumulation and toxicity of PAHs to benthic organisms can be updated by a direct measurement of porewater PAHs using the passive sampling techniques [5]. The data can further be used to evaluate biomagnification of PAHs through trophic transfer using process based bioaccumulation models [11].

In addition, the values can be used as a baseline concentration to conduct both acute and chronic toxicity studies involving the shellfish and finfish species that are important to the Gulf of Mexico, as well as using the Zebrafish model. Hence, the data we will obtain can be used to evaluate the site and species responsive to a variety of toxic thresholds of PAHs in the Gulf of Mexico ecosystem. We anticipate that several other research institutions will conduct toxicity tests to study organisms' physiological processes at the cellular level (genes and their transcripts and expression products, such as proteins and hormones) and whole animals. Such toxicity tests will provide us with information on the effects of dispersed oil on early developmental processes, muscle/skeletal development, growth, immune systems and reproductive processes.

IV. General Work Plan

We have deployed our passive sampler (SPMDs) and collected organisms with seed funding from the NACC in a few locations, such as Terrebone Bay (LA), Barataria Bay (LA), Jose Bay (MS), Perdido Bay (FL), and Cotton Bayou (AL), to measure PAH levels in water and sediment porewater. The locations of these past sampling efforts are delineated in Figure 2.

Additional funding will allow us to conduct a more comprehensive study in the areas sampled and provide a much more accurate assessment of natural resource damages.

We envision an additional 50 sampling locations including several impacted commercial and recreational fishing zones.

Our team has expertise in risk communication. We plan to meet with local community groups located in the Gulf of Mexico area that have been impacted by the oil spill to communicate our findings and obtain their feedback. We will hold similar meetings with EPA and other interested stakeholders. To assist with public outreach, we will work with the Baltimore Aquarium to develop an exhibit on the Gulf of Mexico oil spill.

We have already been monitoring PAHs for the past year with NACC seed funding in more than 40 locations in the Gulf of Mexico, which are shown in Figure 2. Some of the preliminary data on the PAH concentrations are available in Figure 3. Generally, SPMDs showed far greater sensitivity in measuring 'ng/L' levels of dissolved PAHs in the water column and sediment porewater than grab sampling techniques. Once the data from these different matrices are determined, a model of bioavailability and bioaccumulation will be developed for petroleum contamination. We have the capability to develop process and probability based mathematical models to better understand the underlying processes and to synthesize and interpret experimental observations.