EXPERT REPORT
U.S. v. BP Exploration & Production, Inc. et al.

RESPONSES TO BP EXPERT REPORTS

Submitted on Behalf of the United States

Prepared by: Donald F. Boesch (Ph.D.) and Stanley D. Rice (Ph.D.)

Donald F. Boesch (Ph.D.)

Stanley D. Rice (Ph.D.)

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1. SUMMARY CONCLUSIONS

As the authors of expert reports prepared for the United States, we reviewed and evaluated reports prepared by the following experts engaged by BP: Drs. Tunnell, Taylor and Shea and Capt. Paskewich. Their reports drew conclusions that the harm to fish, shellfish and bird populations, shorelines, and (based on inferred toxicity of observed oil concentrations) to organisms living in the offshore Gulf of Mexico was limited in scope and consequences and that those affected components of the Gulf ecosystem have largely recovered. Through detailed evaluation of the information, analyses and interpretations provided in these reports, we respond that:

a) BP's conclusions concerning harm to Gulf ecosystems and resources are not based on direct measurements of actual harm and are at least premature.

b) BP's reports fail to consider all evidence of impacts, neglecting some vulnerable ecosystems and electing not to consider the relevant peer-reviewed literature.

c) BP's sweeping conclusions are drawn based on flawed analyses of selective data.

d) The extent of harm is concealed or diminished by presenting results in the context of large regions not affected by oil contamination.

e) For these reasons, the BP expert reports in no way demonstrate that actual and potential harm was not serious or long-term.

2. COMMON RESPONSES TO THREE REPORTS ADDRESSING ENVIRONMENTAL HARM

2.1. The reports neither individually nor collectively constitute a comprehensive assessment of actual and potential harm.

Four of the expert reports submitted on the behalf of BP address actual or potential harm of the Macondo well blowout to ecosystems and resources of the Gulf of Mexico. The report by Dr. John W. Tunnell addresses impacts on fish and shellfish populations and bird populations.[1] The report by Dr. Elliot Taylor mainly addresses efforts to protect shorelines from oiling and treatment of oiled shorelines and wetlands.[2] The consequences and duration of impacts are considered mainly in the evaluation of the effects of clean-up on shoreline recovery. The report of Captain Frank Paskewich (USCG Retired) evaluates the extent and effectiveness of BP's efforts to minimize or mitigate the effects of the blowout, but also touches on some coastal impacts.[3] The report by Dr. Damian Shea addresses potential harm based on toxicological

[1] Tunnell JW (2014) Expert Report: In Re. Oil Spill by the Oil Rig "Deepwater Horizon" in the Gulf of Mexico, on April 20, 2010. BP Exploration and Production Inc. United States District Court, Eastern District of Louisiana, MDL No. 2179, Section J, New Orleans, LA

[2] Taylor E (2014) Expert Report: In Re. Oil Spill by the Oil Rig "Deepwater Horizon" in the Gulf of Mexico, on April 20, 2010. BP Exploration and Production Inc. United States District Court, Eastern District of Louisiana, MDL No. 2179, Section J, New Orleans, LA

[3] Paskewich CFM (2014) Expert Report: In Re. Oil Spill by the Oil Rig "Deepwater Horizon" in the Gulf of Mexico, on April 20, 2010. BP Exploration and Production Inc. United States District Court, Eastern District of Louisiana, MDL No. 2179, Section J, New Orleans, LA

interpretations of chemical characterization of water and sediment samples and laboratory toxicity testing.[4]

None of these reports presents a comprehensive evaluation of the actual or potential harm to ecosystems and resources of the Gulf of Mexico. Even when considered collectively, they leave out *any* consideration of environmental harm to floating seaweed communities; deep-sea benthic biota including cold-water coral communities; sea turtles and marine mammals; bottom fishes living where hydrocarbons contaminated sediments; and open-ocean fishes with larvae that develop near the sea surface. These are among those components of Gulf ecosystems for which, based on our expert reports prepared for the U.S. Government[5] and the published literature, there is substantial evidence of real or potential harm.

2.2. The reports provide a misleading representation of harm by presenting results in the context of large regions not affected by oil contamination.

In different ways all four of the expert reports present results in a manner that obscures or trivializes observed impacts by placing them in the context of a larger universe extending well beyond the oil spill. This could be in terms of populations of animals for the entire Gulf region, the lengths of shorelines not oiled, or numbers of samples that were not contaminated, as specifically discussed for each expert report below. The Gulf of Mexico is a large space, with a U.S. shoreline length exceeding that from Florida through Maine and vast ocean area and volume. It is rather meaningless to judge harm within such vastness, rather it should be judged within the context of the areas and spaces actually impacted. As a parallel example, one could conclude that Hurricane Katrina had no significant economic impact on the Gulf States as a whole. This may be true, but would that tell the full story? It would certainly conceal the social and economic disruption that occurred in southeastern Louisiana and Mississippi as well as the long-term consequences.

2.3. The reports are based predominantly on new analyses and interpretations of data that have not been professionally vetted or peer-reviewed.

Conclusions of all four expert reports are predominantly based on analyses of data presented for the first time in these reports. There has not been opportunity for government scientists working with the same data through the Natural Resources Damage Assessment or independent academic researchers to review and critique the analyses and interpretation. Except for some analysis of the SCAT data on shoreline oiling that were jointly published with government scientists,[6] the analyses and interpretations in these reports have not been published in the peer-reviewed

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[4] Shea D (2014) Expert Report: In Re. Oil Spill by the Oil Rig "Deepwater Horizon" in the Gulf of Mexico, on April 20, 2010. BP Exploration and Production Inc. United States District Court, Eastern District of Louisiana, MDL No. 2179, Section J, New Orleans, LA

[5] Boesch DF (2014) Expert Report: Actual and potential harm from the Macondo well blowout. United States of America.U.S. v BP Exploration & Production Inc. et al. United States District Court Eastern District of Louisiana MDL No. 2179, Section J, Washington, DC; Rice SD (2014) Expert Report: Toxicolgical impact of the MC252 Blowout, oil spill, and response. United States of America.U.S. v BP Exploration & Production Inc. et al. United States District Court Eastern District of Louisiana MDL No. 2179, Section J, Washington, DC

[6] Michel J, Owens EH, Zengel S, Graham A, Nixon Z, Allard T, Holton W, Reimer PD, Lamarche A, White M, Rutherford N, Childs C, Mauseth G, Challenger G, Taylor E (2013) Extent and degree of shoreline oiling: Deepwater Horizon oil spill, Gulf of Mexico, USA. PLoS One 8:e65087

scientific literature. In contrast, our expert reports rely, almost exclusively, on published analyses that have been peer reviewed.

2.4. The reports do not rely on, or even consider, important peer-reviewed literature germane to actual or potential harm to ecosystems and resources.

As they mainly present the experts' own analysis and interpretation, the reports rely very little on the voluminous literature on the fate and effects of the Macondo well blowout. Furthermore, it appears from the lists of information and sources considered, these experts eschewed consideration of important literature germane to understanding the effects of the release of Macondo well oil—in microbiology and toxicology and concerning plankton, fish, birds and mammals, for example. Key literature that was not considered is identified in the discussion of each of the expert reports in Sections 3, 4, and 5. This is highly unusual, at least for objective scientific discussion, wherein it is generally expected that one must discuss how and why one's findings differ from those already reported in the literature.

2.5. The reports attempt to circumvent or prejudge the ongoing Natural Resources Damage Assessment.

We based our own expert reports on the already published literature and were very cautious in drawing definitive, quantitative conclusions. However, in different ways the BP expert reports attempt to circumvent or prejudge the ongoing Natural Resources Damage Assessment by drawing very broad and definitive conclusions. This is particularly the case in Dr. Shea's report, which presents analyses of extensive NRDA data. In spite of the fact that the NRDA is still ongoing and Dr. Shea only considered limited parts of the currently available data, he is ready to conclude: "with a reasonable degree of scientific certainty" that "there was no harmful exposure of oil-related chemicals or dispersants in the vast majority of the area investigated."[7] Similarly, Dr. Tunnell, who analyzed no NRDA data, concludes: "to a reasonable degree of scientific certainty that the environmental harm from the Deepwater Horizon oil spill was limited and the Gulf has largely recovered," and "the oil spill did not cause any significant adverse effects to fish, shellfish or bird populations, and I do not expect to see any such effects in the future."[8] As will be discussed in the following sections, drawing such sweeping conclusions from their analyses is not scientifically supported. But, at a minimum, such conclusions are premature given the extensive NRDA and research studies that are still underway.

3. EXPERT REPORT OF DR. JOHN W. TUNNELL, JR.

3.1. The analyses focus on species populations not extensively exposed to Macondo well oil.

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[7] Shea D (2014) Expert Report: In Re. Oil Spill by the Oil Rig "Deepwater Horizon" in the Gulf of Mexico, on April 20, 2010. BP Exploration and Production Inc. United States District Court, Eastern District of Louisiana, MDL No. 2179, Section J, New Orleans, LA, p. 3

[8] Tunnell JW (2014) Expert Report: In Re. Oil Spill by the Oil Rig "Deepwater Horizon" in the Gulf of Mexico, on April 20, 2010. BP Exploration and Production Inc. United States District Court, Eastern District of Louisiana, MDL No. 2179, Section J, New Orleans, LA p. 66

Dr. Tunnell's report relies primarily on his own analyses of data from surveys of fish and shellfish populations, commercial and recreational fisheries landings, and Christmas bird counts to conclude that "the evidence is that the fish, shellfish, and bird populations in the northern Gulf of Mexico did *not* suffer significant, long-term harm from the *Deepwater Horizon* oil spill."[9] Such a sweeping conclusion is not supported by his analyses for a number of reasons. The first concerns the fact that most of the species that he chose to assess, while vulnerable where they were exposed to oil resulting from the Macondo blowout, have large portions of their populations included in the analysis that live in naturally protected habitats and along the coast beyond the extent of oiling (See Section 3.2). Dr. Tunnell's analysis does not to any significant degree include fish, shellfish and bird species that live predominantly in offshore waters where they were directly exposed to surface and subsurface oil. Thus, he can hardly extend his conclusion to all species.

For fish and shellfish, Dr. Tunnell's analyses focused on ten species that he suggests are commercially, recreationally or ecologically important. His analyses are based on various data sets derived from commercial and recreational fishery landings or surveys that are independent of the fisheries and undertaken to assess population levels (Table 1). The latter include (a) 40-foot trawl sampling at sites distributed across the continental shelf from off Alabama to the Texas-Mexico border as part of the Southeast Area Monitoring and Assessment Program (SEAMAP) and (b) sampling using a variety of methods undertaken by the Louisiana Department of Wildlife and Fisheries (LDWF).

Table 1. Data sets included in Tunnell's analysis of trends for fish and shellfish over time.

Species	SEAMAP Shelf AL-TX	LDWF All LA coastal areas	Commercial landings	Recreational landings
Brown shrimp	40 ft. trawl		Gulfwide	
White shrimp	40 ft. trawl		Gulfwide	
Blue crab		16 ft. trawl	Gulfwide, LA	
Oyster		stock assessment	Gulfwide, LA	
Red drum		trammel	MS only	Gulfwide ex. TX
Red snapper	40 ft. trawl		Gulfwide ex. MS	Gulfwide
Sand seatrout		16 ft. trawl	Gulfwide	Gulfwide ex. TX
Atlantic croaker		16 ft. trawl	Gulfwide	Gulfwide
Bay anchovy		seine		
Gulf menhaden		seine	Gulfwide	

With the exception of the red snapper, all of the species considered by Dr. Tunnell live all or significant parts of their life stages in sounds, bays and bayous or on the nearshore continental shelf. Relatively small portions of the populations included in Dr. Tunnell's analysis live in the surface waters and the bottom habitats of offshore Gulf where the oil emanating from the Macondo blowout resulted in the heaviest

[9] Tunnell JW (2014) Expert Report: In Re. Oil Spill by the Oil Rig "Deepwater Horizon" in the Gulf of Mexico, on April 20, 2010. BP Exploration and Production Inc. United States District Court, Eastern District of Louisiana, MDL No. 2179, Section J, New Orleans, LA, p. 4

sustained exposure.[10] Moreover, Dr. Tunnell includes no separate analysis of the populations of these species within the estuarine and nearshore areas where they were actually heavily exposed to oil, just state or region-wide averages.

White shrimp, blue crab, red drum, sand sea trout, Atlantic croaker, and Gulf menhaden spawn on the inner shelf at water depths typically less than 100 feet, where their larvae develop and can be swept into estuarine nurseries. Oysters and bay anchovies can complete their lives within the estuaries. Brown shrimp can spawn and live as adults farther out on the continental shelf, but post-larvae and juveniles must be nurtured with estuarine nurseries. Of course populations of these these coastal species did not all escape exposure to Macondo well oil. As shown in Figure 1, some portions of the estuarine nurseries in Chandeleur Sound and Barataria and Terrebonne bays experienced moderate to heavy oiling of marshes based on SCAT surveys.[11] Such shoreline oiling is indicative the extent of substantial floating oil entering those bays and sounds and also provides a source of chronic contamination within the area. Light and trace oiling was even more widespread in these estuaries, but in general very little shoreline oiling was observed in Louisiana Coastal Study Areas 5, 6 and 7. However, because Dr. Tunnell presents and analyzes Louisiana-wide average abundances, large portions of the populations of the coastal species included in his analyses experienced relatively little exposure to oil.

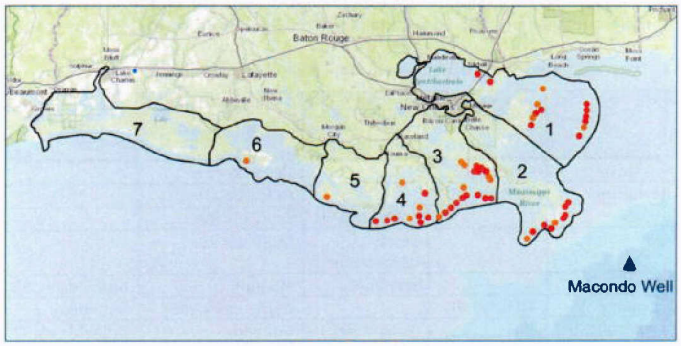

Figure 1. Only the lower portions of four of the seven Coastal Study Areas (CSAs) historically sampled by the LDWF experienced moderate (orange) to heavy (red) shoreline oiling. Dr. Tunnell's analysis relied on abundances averaged over all seven areas, not just those experiencing significant oil contamination.

Red snapper is the only species considered by Dr. Tunnell that resides in offshore environments, including the deeper parts of the continental shelf. However, red snapper populations are difficult to assess based on the SEAMAP sampling 40-foot

[10] Boesch DF (2014) Expert Report: Actual and potential harm from the Macondo well blowout. United States of America.U.S. v BP Exploration & Production Inc. et al. United States District Court Eastern District of Louisiana MDL No. 2179, Section J, Washington, DC

[11] Michel J, Owens EH, Zengel S, Graham A, Nixon Z, Allard T, Holton W, Reimer PD, Lamarche A, White M, Rutherford N, Childs C, Mauseth G, Challenger G, Taylor E (2013) Extent and degree of shoreline oiling: Deepwater Horizon oil spill, Gulf of Mexico, USA. PLoS One 8:e65087

trawls.[12] Red snapper tend to congregate around outcroppings and reefs that cannot be trawled and larger fish avoid the trawls. Dr. Tunnell also did not consider the evidence of lesions in red snapper and other bottom-dwelling fish, including tilefish, that has been associated with likely exposure to Macondo well oil.[13] He included no analyses of other deeper water species, such as rock shrimp and royal red shrimp, for which both SEAMAP and commercial landing data should be available. Furthermore, Dr. Tunnell neither analyzed nor discussed impacts on open-ocean, pelagic species such as the tunas, amberjack and mahi-mahi for which toxic effects have been experimentally demonstrated at low and short-term exposure to Macondo well oil. Potential harm to sensitive early life stages of fishes is discussed further in Section 5.

Dr. Tunnell's expert report considers effects on bird populations under the heading: "Bird Populations Did Not Suffer Significant Harm From the Deepwater Horizon Oil Spill".[14] The headline conclusion, stated with "reasonable certainty," is drawn from very limited scientific publications, anecdotal press reports, some NRDA oiling data, and graphical representations of sighting from the Audubon Christmas Bird Count and North American and North American Breeding Bird Survey. Population estimates based solely on counts at land-based sites are inadequate to assess the effects on coastal and offshore bird populations that were most susceptible to Macondo well oil, including such species as laughing gull, brown pelican and northern gannet.

Dr. Tunnell underestimates the impacts to bird populations, potentially by a hundred fold. He cites Live Bird Oiling Rate Data comparing the 2,995 birds with even a trace of oil to the 447,618 birds observed, i.e. less than 1%. However, he does not consider the Deepwater Horizon Response Consolidated Fish and Wildlife Collection Report that reports more than twice that number of birds (6,147) collected dead, 37% of which were visibly oiled.[15] It has long been appreciated that even these body counts greatly underestimate the true mortality. Some carcasses escape detection because they are small or hidden among marsh plants; others decompose or are fed upon before being collected; and still others are simply missed because of limited surveillance or are swept out to sea. Studies not mentioned by Dr. Tunnell provide widely varying estimates of bird mortality that range into the hundreds of thousands. One model estimated that there was a less than 2.5% chance that the number of birds killed was less that 160,000[16]—more than 53 times the number Dr. Tunnell suggests had even a trace of oil.

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[12] Cowan JH (2011) Red Snapper in the Gulf of Mexico and US South Atlantic: Data, Doubt, and Debate. Fisheries 36:319-331

[13] Murawski SA, Hogarth WT, Peebles EB, Barbeiri L (2014) Prevalence of external skin lesions and polycyclic aromatic hydrocarbon concentrations in Gulf of Mexico fishes, post-Deepwater Horizon. Trans Am Fish Soc 143:1084-1097

[14] Tunnell JW (2014) Expert Report: In Re. Oil Spill by the Oil Rig "Deepwater Horizon" in the Gulf of Mexico, on April 20, 2010. BP Exploration and Production Inc. United States District Court, Eastern District of Louisiana, MDL No. 2179, Section J, New Orleans, LA, p 59

[15] U.S. Fish and Wildlife Service (2011) Deepwater Horizon Response Consolidated Fish and Wildlife Collection Report http://www.fws.gov/home/dhoilspill/collectionreports.html

[16] Haney JC, Geiger HJ, Short JW (2014) Acute bird mortality from the Deepwater Horizon MC 252 oil spill. II. Carcass sampling and exposure probability estimates for coastal Gulf of Mexico. Mar Ecol Prog Ser doi: 10.3354/meps10839

3.2. Analyses of regional trends are incapable of quantifying impacts on resources within the geographic areas that were actually exposed to substantial oiling.

Dr. Tunnell's expert report presents survey abundance data, commercial and recreational catch statistics, and bird counts as averages (means) for areas far larger than that affected directly by Macondo well oil (Figure 2). Over 80% of the continental shelf surveyed in the SEAMAP trawl surveys extended outside of the large region that experienced significant floating oil emanating from the blowout.[17] Three of the seven LDWF CSAs in Louisiana experienced no more than a trace of oiling beyond the Gulf shoreline (Figure 1).

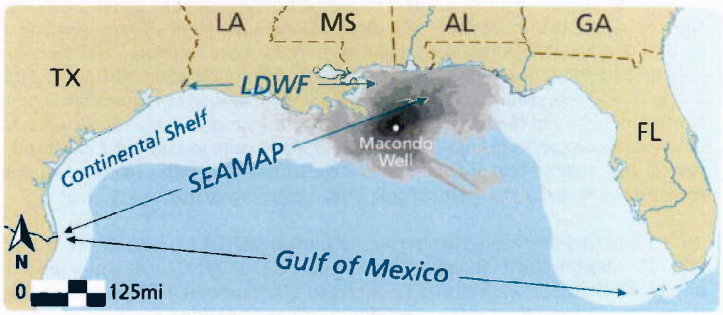

Figure 2. The geographic scales of the databases analyzed by Dr. Tunnell are far more expansive that scope of oiling from the Macondo well: landings data for entire U.S. Gulf of Mexico; SEAMAP trawl sampling on the continental shelf off Alabama through Texas; and LDWF sampling in seven Coastal Study Areas throughout Louisiana. Shades in the oil footprint represent the number of days on which oil was observed.

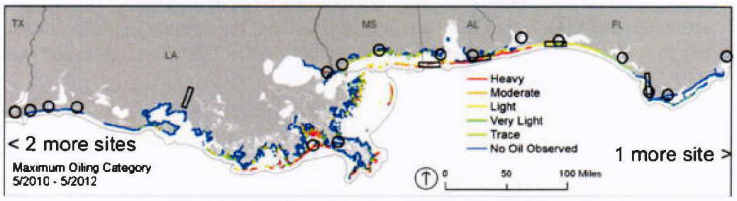

Figure 3. Dr. Tunnell summed bird counts across several sites along the northern Gulf Coast (Audubon Christmas Bird Count circles, North American Breeding Bird Survey rectangles), but most of sites did not experience even moderate oiling nearby.

Among the five survey routes for the North American Breeding Bird Study chosen by Dr. Tunnell, only the Dauphin Island and Alabama Point routes were near sites that

[17] Source for oil footprint in Figure 2: http://gomex.erma.noaa.gov/erma.html#/x=-88.86234&y=29.07287&z=6&layers=23036+5723

experienced more than very light oiling (Figure 3). There was no survey route anywhere near the wildlife-rich southeastern Louisiana, which received the brunt of the oiling. Of the 20 of the 15-mile diameter circles chosen from the Audubon Christmas Bird Count, 12 were in areas where shorelines experienced no more than a trace of oiling.[18]

Most of Dr. Tunnell's commercial and recreational landing data represent totals for the whole of the U.S. Gulf of Mexico or most of it, an even more expansive area (Table 1). Even for blue crab and oyster landing data for Louisiana, only statewide averages that include substantial areas not exposed to Macondo well oil are presented. At least for oysters, the LWFD annually reports on landings by CSA,[19] and therefore calculations could be made for specific CSAs.

The premise of Dr. Tunnell's expert report is that significant harm would only occur if the populations of fish, shellfish or birds were demonstrably affected "in the relevant area." Because of the overly broad scope of the "relevant areas" he chose, for there to be significant harm to brown shrimp populations, for example, either the total number of shrimp residing on the continental shelf from Alabama to Mexico or the commercial landings from the entire U.S. Gulf of Mexico would have to be reduced by more than half based on Dr. Tunnell's Figures 6 and 10, respectively. Even if all the brown shrimp residing in the vast area exposed to Macondo well oil (Figure 2) were totally annihilated it would be virtually impossible to meet this extreme standard because the "relevant areas" extend so far beyond the area exposed to Macondo well oil.

3.3. The statistical methods used are inappropriate for identifying significant impacts to assessed populations.

Dr. Tunnell plots fisheries-independent (SEAMAP and LDWF catch-per-unit-effort) and dependent (commercial and recreational landings) data as means for each year over the 10-20 year time periods considered. For the fisheries-independent data, he performs linear regression analysis to portray trends in abundance, represented as the logarithm of annual mean catch-per-unit effort, over the last ten years. Linear regression is a statistical technique that defines a straight line that best fits the relationship between an independent (year in this case) and a dependent (abundance) variable. With time as the independent variable, linear regression is often used to depict trends over time in observations. One can also compute confidence limits around the regression line that indicate the range above or below the line in which the preponderance of observations would be expected to fall for a given year.

Dr. Tunnell's use of linear regression analysis for statistical determination of the effects of oil from the Macondo well blowout is seriously flawed for several reasons. A few examples will illustrate these flaws.

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[18] Locations of the 15-mile diameter circles surveyed in the Audubon Christmas Bird Count can be found at http://audubon.maps.arcgis.com/apps/StorytellingTextLegend/index.html?appid=6332a1e8fcf940ea95d80cdbb48204d3

[19] Louisiana Department of Wildlife & Fisheries (2013) Oyster Stock Assessment Report of the Public Oyster Seed Areas of Louisiana Seed grounds and Seed Reservations. Oyster Data Report Series, No. 19, Baton Rouge, LA

Three of the ten-year plots and regressions included in Dr. Tunnell's report are presented in Figure 4. In all three cases the values for the years after the Macondo well blowout were lower than the years during and before, as well as the ten-year averages. In each case Dr. Tunnell concludes that the decline is not a result of the Macondo well oil because they are "well within the trend lines that began in pre-spill years." By this, he apparently means they fall within the 95% confidence intervals for the regression equation. However, the regression lines and confidence limits presented by Dr. Tunnell were computed from data from both pre-Macondo and post-Macondo years. Consequently, comparing post-Macondo values to the trend lines and confidence limits becomes a self-fulfilling prediction.

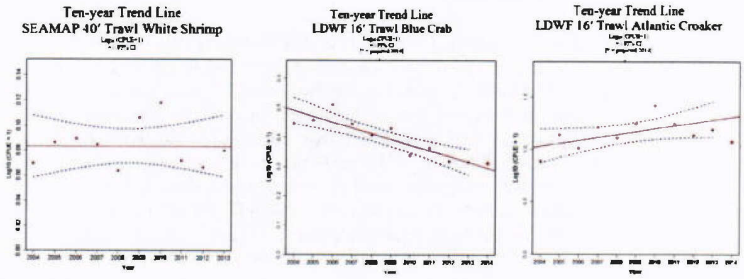

Figure 4. Ten-year trends in abundance included in Figures 9, 12 and 30 (left to right) of the Tunnell expert report. Solid red lines are the linear regressions and dashed blue lines are the 95% confidence intervals.

Take the case of the blue crab. Just because blue crab abundance had been declining between 2004 and 2010, there is no basis to assume that abundance would have continued to do so in 2010-2014 in the absence of oil contamination. So, here Dr. Tunnell dismisses the low population levels observed since the Macondo well blowout by comparing them to a hypothetical declining baseline, with no explanation of why the baseline should be declining.

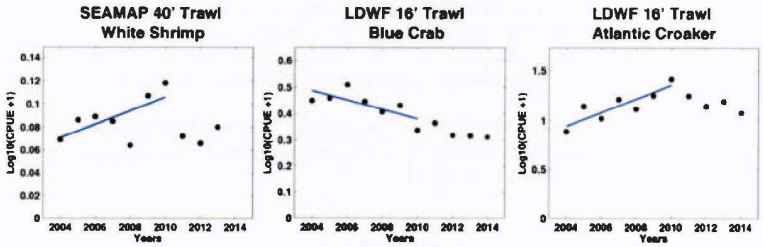

Figure 5. Here we compare the average annual abundance of white shrimp (SEAMAP sampling) and Atlantic croaker (LDWF sampling) in years after the Macondo well blowout to the regression trend lines computed based just on those years prior to the blowout as a more appropriate reference for comparison.

Consider Atlantic croaker and white shrimp. If the regression lines and confidence limits were appropriately computed using only pre-Macondo data, abundances after 2010 clearly would fall well below the regression line (Figure 5),[20] as Atlantic croaker abundance declined by one-half (the numbers are presented in logarithms of catch-per-unit-effort). Although we this do not accept this as an appropriate statistical test, if Dr. Tunnell were consistent with his own criteria, he would have to conclude then that there was harm to Atlantic croaker and white shrimp populations.

Dr. Tunnell's use of regression analysis does not meet contemporary standards of fisheries science and would not pass muster in peer-review for a journal article. More appropriate statistical technique are in wide use for the detection of change in such survey data, including a form of time-series analysis called intervention analysis[21] and analyses based on generalized linear models.[22]

3.4. Discussion of water and tissue chemistry data is irrelevant to exposure to Macondo well oil.

Dr. Tunnell presents his opinions on chemistry drawn from a poster presentation by Texas A & M chemist Terry Wade and the deposition of NOAA's Dr. Amy Merten. Neither of these sources includes substantiating data. Dr. Tunnell also cites three sources of information on contaminants of concern in seafood samples. These considerations lead him to conclude that there was not "widespread or continuing exposure to MC252 oil for fish and shellfish species to levels that would be suggestive of significant adverse impact to populations."[23] This is an extraordinary overreach, based neither on critical review of water and tissue data nor on an understanding of contaminant chemistry. Fish and shellfish can be exposed to and harmed by Macondo well oil even though their edible tissues do not exceed concentrations of concern from a human health perspective. In fact, Dr. Tunnell mentions one published study that found polycyclic aromatic hydrocarbon (PAH) levels in seafood samples, while not posing a risk to human health, declined after cessation of exposure to Macondo well oil.[24] At the same time, he fails to consider evidence published in the peer-reviewed literature that Macondo well PAHs were accumulated in zooplankton[25] and livers of red snapper on the outer continental shelf.[26] Such bioaccumulation provides substantial evidence of exposure and the potential for associated toxicological effects.

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[20] Confidence limits for the pre-Macondo regression are not shown because the smaller number of years included in the calculation would make them incomparable to the limits depicted by Dr. Tunnell.
[21] Fogarty MJ, Miller TJ (2004) Impact of a change in reporting systems in the Maryland blue crab fishery. Fisheries Research 68:37-43
[22] Stefansson G (1996) Analysis of groundfish survey abundance data: Combining the GLM and delta approaches. Ices Journal of Marine Science 53:577-588
[23] Tunnell JW (2014) Expert Report: In Re. Oil Spill by the Oil Rig "Deepwater Horizon" in the Gulf of Mexico, on April 20, 2010. BP Exploration and Production Inc. United States District Court, Eastern District of Louisiana, MDL No. 2179, Section J, New Orleans, LA, p. 21
[24] Xia K, Hagood G, Childers C, Atkins J, Rogers B, Ware L, Armbrust K, Jewell J, Diaz D, Gatian N, Folmer H (2012) Polycyclic aromatic hydrocarbons (PAHs) in Mississippi seafood from areas affected by the Deepwater Horizon oil spill. Environ Sci Technol 46:5310-5318
[25] Mitra S, Kimmel DG, Snyder J, Scalise K, McGlaughon BD, Roman MR, Jahn GL, Pierson JJ, Brandt SB, Montoya JP, Rosenbauer RJ, Lorenson TD, Wong FL, Campbell PL (2012) Macondo-1 well oil-derived polycyclic aromatic hydrocarbons in mesozooplankton from the northern Gulf of Mexico. Geophys Res Lett 39:L01605
[26] Murawski SA, Hogarth WT, Peebles EB, Barbeiri L (2014) Prevalence of external skin lesions and polycyclic aromatic hydrocarbon concentrations in Gulf of Mexico fishes, post-Deepwater Horizon. Trans Am Fish Soc 143:1084-1097

3.5. Emphasis on the implied resilience of Gulf of Mexico ecosystems is gratuitous without any absolute or comparative measure of resilience.

The claim that Gulf of Mexico ecosystems are exceptionally resilient is made to suggest that they would not be harmed by a hydrocarbon blowout, even one as massive as from the Macondo well. Dr. Tunnell's evidence for this resilience is based entirely on the observation that the Gulf of Mexico produces the second highest seafood catch in the U.S., notwithstanding the many natural and anthropogenic impacts that have affected the habitats and species of the northern Gulf over the past 50-60 years.[27] These impacts include loss of 25% of coastal wetlands in Louisiana, 20-100% of seagrass beds depending on location, and 50% of oyster reefs; invasions of nonnative species; and creation of large dead zones. This is a specious argument, not based on any estimation of what the production of seafood would be absent those impacts. Nor is the claim founded on comparisons with any other ecosystems: resilient compared to what? A more compelling conclusion founded on contemporary ecological theory might be that because of these multiple stressors, the resilience of the Gulf of Mexico is compromised such that additional stressors, even if minor by comparison, might be synergistic rather than simply additive. For example, scientists have posited that feedbacks and synergistic effects occur between hypoxia (harmfully low oxygen concentrations) characteristic of dead zones and other pollutants.[28]

3.6. Definitive conclusions related to harm are unsupported, highly speculative and premature.

The expert report by Dr. Tunnell claims to draw the conclusion that the Macondo well blowout did not result in significant adverse effects on populations of fish, shellfish and birds with a reasonable degree of scientific certainty. To arrive at this conclusion he relied on analyses based on: species populations that experienced little exposure, average abundances over areas far greater than the area that was impacted, and inappropriate statistical methods. Simply put, to accept his approach one would have to concede that significant harm would only occur only if inshore populations of fish, shellfish and birds had been decimated throughout the entire Gulf of Mexico. Furthermore, he attempts to draw a definitive conclusion from inappropriate data analysis, while the much more detailed Natural Resource Damage Assessment and Gulf of Mexico Research Initiative are still pursuing rigorous quantification of effects. Even from a most generous perspective, Dr. Tunnell's conclusions must be regarded as highly speculative and premature.

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[27] Tunnell JW (2014) Expert Report: In Re. Oil Spill by the Oil Rig "Deepwater Horizon" in the Gulf of Mexico, on April 20, 2010. BP Exploration and Production Inc. United States District Court, Eastern District of Louisiana, MDL No. 2179, Section J, New Orleans, LA, p. 11

[28] Hall J, Diaz RJ, Gruber N, Wilhelmison D (2013) Impacts of multiple stressors. In: Noone KJ, Sumaila UR, Diaz RJ (eds) Managing Ocean Ecosystems in a Changing Climate: Sustainability and Economic Perspectives. Elsevier, Burlington, MA

4. EXPERT REPORTS OF ELLIOT TAYLOR, PH.D. AND FRANK PASKEWICH, CAPT., USCG (RET.).

4.1. The reports mainly address the effectiveness of mitigation efforts and the assessment and treatment of oiled shorelines and do not assess actual or potential harm.

The principal objective of Dr. Taylor's expert report is to demonstrate that BP responded effectively in assessing and treating oiled shorelines and did so in conjunction with the Unified Command. Dr. Taylor was retained by BPXP also to evaluate "the impact to and recovery of the oiled shoreline, including beaches and marshes;"[29] however, his evaluation was largely visual, with some information on marsh vegetation height and biomass and no chemical characterization of contamination. His report cannot be considered a comprehensive chemical and biological assessment of the acute and chronic harm to the coastal ecosystem, even just due to shoreline oiling. Capt. Paskewich was retained by BP "to evaluate the nature, extent and degree of effectiveness of BP's efforts to minimize and mitigate the effects of the Deepwater Horizon oil spill." In our response, we will not evaluate the adequacy of the Unified Command's assessment and treatment of shorelines or the effectiveness of the Command's efforts to minimize and mitigate effects. Rather, we will address inferences drawn in the Taylor and Paskewich reports that relate to actual or potential environmental harm.

4.2. The reports present a misleading depiction of the scale of actual or potential harm.

As with Dr. Tunnell's report, spatial representations made in the expert reports of Dr. Taylor and Capt. Paskewich, whether intentionally or not, have the effect of trivializing the scale of shoreline contamination by Macondo well oil. For example, Figure 6, which was included in both the Taylor and Paskewich reports, depicts changes in oiling levels over time against a background of the cumulative length of shoreline surveyed, not the shoreline actually included in each survey. As Dr. Taylor indicates, surveys extended well beyond where the oil was transported.[30] By any reasonable standard of comparison, the harm to shorelines in absolute terms (1,100 miles receiving some oil, a distance greater than the drive from New Orleans to Washington, DC) must be considered to have resulted in real or potential harm of serious proportions.

The Taylor report also makes the point that most of the shoreline affected was no more than lightly oiled, stating that at the peak of shoreline oiling "only approximately one-third of the oiled shoreline (approximately 360 miles) was categorized as heavy or moderate oiling."[31] Such a proportion is not unusual for oil spills. For example, while

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[29] Taylor E (2014) Expert Report: In Re. Oil Spill by the Oil Rig "Deepwater Horizon" in the Gulf of Mexico, on April 20, 2010. BP Exploration and Production Inc. United States District Court, Eastern District of Louisiana, MDL No. 2179, Section J, New Orleans, LA, p. 1

[30] Taylor E (2014) Expert Report: In Re. Oil Spill by the Oil Rig "Deepwater Horizon" in the Gulf of Mexico, on April 20, 2010. BP Exploration and Production Inc. United States District Court, Eastern District of Louisiana, MDL No. 2179, Section J, New Orleans, LA, p.17

[31] Taylor E (2014) Expert Report: In Re. Oil Spill by the Oil Rig "Deepwater Horizon" in the Gulf of Mexico, on April 20, 2010. BP Exploration and Production Inc. United States District Court, Eastern District of Louisiana, MDL No. 2179, Section J, New Orleans, LA p. 40

the *Exxon Valdez* spill resulted in the oiling of 1,189 miles of shoreline, heavy or moderate oiling was observed over only 17% of the shoreline oiled (202 miles).[32] In any case, this hardly diminishes the actual or threatened harm due to oiling, as moderate to heavy oiling extended over a shoreline length equivalent to the driving distance between New Orleans and Houston.

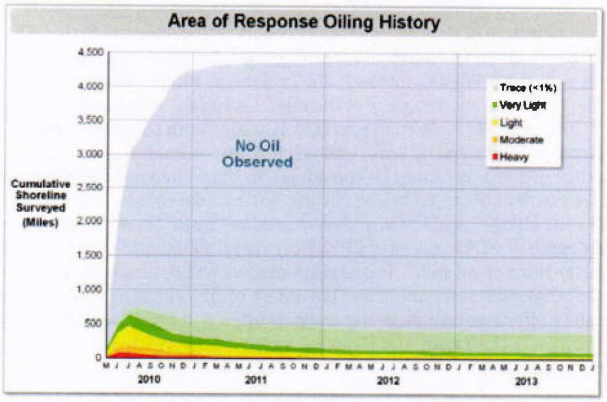

Figure 6. As demonstrated by this graph (Figure 15 in either report) the Taylor and Paskewich expert reports attempt to trivialize the scale of shoreline oiling by comparing it to the cumulative length of shoreline surveyed over a much broader area where no oil was observed.

Both Capt. Paskewich[33] and Dr. Taylor[34] suggest that the Unified Command's spill control efforts protected extensive shoreline from oiling, but neither report makes any attempt to quantify how much shoreline was protected. Capt. Paskewich estimates that skimming, burning and subsea and surface dispersant applications kept or removed 1.2 million barrels of oil from floating on the surface and thus from potentially impacting shorelines. While an evaluation of his estimate is beyond the scope of our response on the question of actual or potential harm, we note that it is dependent on some highly uncertain assumptions because a substantial part of the estimate is based on rough estimates of the effectiveness of subsea dispersants that are still subject to disagreement among subject matter experts.[35] Nonetheless, the fact that large stretches of Gulf of Mexico shoreline surveyed were not oiled was predominantly because physical forces (winds, currents and tides) did not carry oil to those shores rather than the success of offshore mitigation efforts. Other than by finally capping the

[32] Owens EH (1991) Shoreline conditions following the Exxon Valdez oil spill as of fall 1990. Proceedings of the 14th Arctic and Marine Oil Spill Program Technical Seminar, Environment Canada, Ottawa, ON, 579-606.
[33] Paskewich CFM (2014) Expert Report: In Re. Oil Spill by the Oil Rig "Deepwater Horizon" in the Gulf of Mexico, on April 20, 2010. BP Exploration and Production Inc. United States District Court, Eastern District of Louisiana, MDL No. 2179, Section J, New Orleans, LA, p. 19
[34] Taylor E (2014) Expert Report: In Re. Oil Spill by the Oil Rig "Deepwater Horizon" in the Gulf of Mexico, on April 20, 2010. BP Exploration and Production Inc. United States District Court, Eastern District of Louisiana, MDL No. 2179, Section J, New Orleans, LA, p. 8
[35] Federal Interagency Solutions Group, Oil Budget Calculator Science and Engineering Team. Oil Budget Calculator, Deepwater Horizon (November 2010) (TREX-009182)

well after 87 days, Unified Command's spill control efforts likely protected only a small portion of the nearly 4,000 miles of shorelines designated as "No Oil Observed"[36] in Figure 6.

Finally, Capt. Paskewich's report describes the harm caused to oyster populations as a result of diversions of fresh Mississippi River water undertaken by the State of Louisiana in an attempt to keep oil out of coastal wetlands.[37] As discussed in Dr. Boesch's expert report these diversions may have contributed, along with other factors, to significant declines in oyster populations and harvests in CSAs 2 and 3 that continue to the present.[38] Despite whether these diversions were ultimately effective, they would not have been undertaken without the impending risk of substantial exposure to oil from the Macondo well blowout.

4.3. The Shoreline Cleanup Assessment Technique (SCAT) is designed to evaluate oiling and make cleanup recommendations and is not intended to characterize harm from coastal oiling.

Much of Dr. Taylor's report is based on information derived from SCAT surveys undertaken within the Unified Command framework. These surveys were used to assess and document the location, degree and character of shoreline oiling quickly in order to determine appropriate cleanup techniques and cleanup endpoints. The surveys provided certain information that can contribute to the determination of real or potential harm, but do not by themselves support such a determination. In fact, to provide sense of the scale of potential coastal harm, Dr. Boesch's expert report used a publication that summarized the SCAT data that was co-authored by Dr. Taylor as well as government scientists.[39] However, it must be kept in mind that SCAT was not designed or implemented to assess damages and that ongoing NRDA studies are aimed at better quantifying damages.

To be effective in mitigation, SCAT surveys had to be done quickly, requiring characterization of large segments of shoreline, often from boat or aircraft. Several NRDA surveys found at least 88.6 miles of oiled shoreline that were not designated as oiled by SCAT teams.[40] Although the shoreline is a dynamic environment where oil can reach shore and then wash away, SCAT teams could not be in all places at all times. Thus, SCAT surveys cannot provide a completely comprehensive assessment of all oiled areas.[41] Cleanup endpoints allowed for some oil remaining in certain shoreline

[36] As used during the SCAT process, "No Oil Observed" does not mean that there was no oil present: "Our terminology is NOO, no oil observed or no visible oil. And so trace amounts, if it wasn't visible, wasn't tactile, it—it was recorded as no visible oil or no oil observed." Michel Dep. 292:15-292:20

[37] Paskewich CFM (2014) Expert Report: In Re. Oil Spill by the Oil Rig "Deepwater Horizon" in the Gulf of Mexico, on April 20, 2010. BP Exploration and Production Inc. United States District Court, Eastern District of Louisiana, MDL No. 2179, Section J, New Orleans, LA, p. 66-88

[38] Boesch DF (2014) Expert Report: Actual and potential harm from the Macondo well blowout. United States of America.U.S. v BP Exploration & Production Inc. et al. United States District Court Eastern District of Louisiana MDL No. 2179, Section J, Washington, DC, p. 36

[39] Michel J, Owens EH, Zengel S, Graham A, Nixon Z, Allard T, Holton W, Reimer PD, Lamarche A, White M, Rutherford N, Childs C, Mauseth G, Challenger G, Taylor E (2013) Extent and degree of shoreline oiling: Deepwater Horizon oil spill, Gulf of Mexico, USA. PLoS One 8:e65087

[40] Plan for Assessment of the Shorelines Where 2010 Rapid Assessment Surveys Identified Shoreline Oiling That Were Not Surveyed by DWH SCAT Teams (February 21, 2014), p. 1

[41] Deposition of Dr. Jaqui Michel at 289-290.

segments where the concentration of the oil was sufficiently low that the risk of harm from cleanup efforts was deemed more threatening than the threat from the residual oil.[42]

4.4. A significant extent of shorelines that were moderately or heavily oiled remained contaminated at least three years after the blowout.

As one would expect, oil on shorelines that were only lightly oiled visually disappeared over time. Also, shorelines that were moderately to heavily oiled became less so as a result of shoreline cleanup and natural processes, including physical transport and biodegradation. Nonetheless, three years later (May-June 2013) at least traces of oil were still being found along 145 of the 604 miles of shoreline in Mississippi, Alabama and Florida that were oiled in 2010.[43] This is not so much the result of the ineffectiveness of cleanup efforts as the remobilization and transport by waves and currents of oily residues buried on beaches or nearshore sandbars. Oily residues are still being found on some of the beaches as recently as the end of August 2014.[44]

For moderately to heavily oiled wetlands, the lingering contamination may be providing even more significant chronic exposure to potentially toxic hydrocarbons because biodegradation is slowed in oxygen-poor wetland soils. While the extent of moderately and heavily oiled wetlands, based on visual inspection, declined considerably from 2010 through 2011, as shown in Figure 17 in Dr. Taylor's report, the extent of wetlands that appeared to be in any way oiled has declined little since 2011. Moreover, the degree of oiling was determined by visual inspection not chemical analysis. A recent peer-reviewed article demonstrated that concentrations of polycyclic aromatic hydrocarbons (PAHs) in oiled marshes in Breton Sound, Barataria Bay, and Terrebonne Bay, while substantially diminished from levels observed just after oiling in 2010, remained 33 times higher than concentrations measured before oil slicks arrived.[45] This study also found that wetland soil concentration levels were "not well-circumscribed by the rapid shoreline assessment (a.k.a. SCAT) of relative oiling." The authors went on to state: "The SCAT team assessments are a necessary first-order assessment for many purposes, including real-time response operations, but these assessments may not be useful for quantifying relationships between dose and response, changes with time, or spatial distribution horizontally and vertically."

4.5. The broader and longer-term consequences of wetland oiling are understated.

Dr. Taylor's expert report gives the impression that: it was only plants along the marsh edge that were affected; oil did not penetrate deep into the marsh or marsh soils; and

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[42] Shoreline Clean-up Completion Plan (November 2, 2011) (Deposition Exhibit 12184) at 12, OSAT-2 Report at 6.

[43] Michel J, Nixon Z, Holton W, White M, Zengel S, Csulak F, Rutherford N, Childs C (2014) Three Years of Shoreline Cleanup Assessment Technique (SCAT) for the Deepwater Horizon Oil Spill, Gulf of Mexico, USA. International Oil Spill Conference Proceedings 2014:1251-1266, Table 4.

[44] Perkinson D, Pace J (2014) FDEP Beach Monitoring Report. Escambia County segment FLES2-005 and FLES1-035 (NPS Ft Pickens). Florida Department of Environmental Protection, Tallahassee, Fl

[45] Turner RE, Overton EB, Meyer BM, Miles MS, McClenachan G, Hooper-Bui L, Engel AS, Swenson EM, Lee JM, Milan CS, Gao H (In Press) Distribution and recovery trajectory of Macondo (Mississippi Canyon 252) oil in Louisiana coastal wetlands. Marine Pollution Bulletin http://dx.doi.org/10.1016/j.marpolbul.2014.08.011

damaged vegetation has substantially recovered.[46] He bases his findings on marsh vegetation recovery on his own assessment of NRDA data and a yet unpublished Louisiana State University study related to vegetation cover, biomass, and stem density. No data on soil contaminants or other biota were presented. Data plots in Figures 19 and 20 of Dr. Taylor's report clearly show that the percent live cover and below-ground biomass (indicative of health roots and rhizomes) at moderately to heavily oiled sites remained lower than sites not oiled or lightly oiled into the fall of 2013 and 2012, respectively.

Dr. Taylor does not acknowledge that petroleum hydrocarbons matching Macondo well oil were detectable chemically if not visually farther into marshes (as much as 100 meters).[47] He gives no consideration to journal articles that demonstrated that heavily oiling resulted in some cases in complete plant mortality and the eroding away of wetland soils, resulting in episodic shoreline retreat[48] and further susceptibility to wave erosion.[49] Where this occurred, the loss of wetlands is effectively permanent. He also chose not to discuss the impacts of the oiling on marshes in the Mississippi Delta in the context of their high susceptibility due to very high rates of relative sea level rise and limited sediment for soil accretion. Dr. Taylor also does not consider the impacts of hydrocarbon contamination of marsh soils on associated arthropods and fishes that have been demonstrated in the peer-reviewed literature, as summarized in Dr. Boesch's expert report.[50]

4.6. Definitive conclusions related to harm are unsupported, highly speculative and premature.

Dr. Taylor drew findings that shoreline oiling was modest, substantially limited by spill control efforts and rapidly decreased and, further, that wetlands experienced substantial recovery. As discussed above, these findings rest on faulty assumptions, data and analyses. Moreover, definitive conclusions drawn from these findings about actual and potential harm are unsupported, speculative and premature. Assessments should be based on measured damages rather than predominantly on SCAT data intended for mitigation and response rather than assessment of harm. The unprecedented extent of shoreline oiling must be considered rather than misleading comparisons to the extensive Gulf shorelines that fortunately were not contaminated by oil slicks. The fact that some beaches and marshes still experience oil contamination four years after the cessation of the Macondo blowout must be brought into the

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[46] Taylor E (2014) Expert Report: In Re. Oil Spill by the Oil Rig "Deepwater Horizon" in the Gulf of Mexico, on April 20, 2010. BP Exploration and Production Inc. United States District Court, Eastern District of Louisiana, MDL No. 2179, Section J, New Orleans, LA p. 44

[47] Turner RE, Overton EB, Meyer BM, Miles MS, McClenachan G, Hooper-Bui L, Engel AS, Swenson EM, Lee JM, Milan CS, Gao H (In Press) Distribution and recovery trajectory of Macondo (Mississippi Canyon 252) oil in Louisiana coastal wetlands. Marine Pollution Bulletin http://dx.doi.org/10.1016/j.marpolbul.2014.08.011

[48] Silliman BR, van de Koppel J, McCoy MW, Diller J, Kasozi GN, Earl K, Adams PN, Zimmerman AR (2012) Degradation and resilience in Louisiana salt marshes after the BP–Deepwater Horizon oil spill. Proc Natl Acad Sci USA 109:11234-11239

[49] McClenachan G, Turner RE, Tweel AW (2013) Effects of oil on the rate and trajectory of Louisiana marsh shoreline erosion. Env Res Lett 8:044030

[50] Boesch DF (2014) Expert Report: Actual and potential harm from the Macondo well blowout. United States of America.U.S. v BP Exploration & Production Inc. et al. United States District Court Eastern District of Louisiana MDL No. 2179, Section J, Washington, DC, p. 33-36

evaluation. And, evidence of lingering chemical contamination and its effects on organisms other than wetlands plants must also be considered.

5. Expert Report of Dr. Damian Shea

5.1. Findings are derived from estimates of toxicity based on chemical measurements, not on direct measurement of toxic effects.

Dr. Shea's findings of limited potential harm in Gulf waters and sediments are based entirely on comparing chemical measurements of environmental concentrations to EPA Water Quality Benchmarks based primarily on bioassays that assess acute narcotic effects (and not on direct measurements of toxicity of Macondo well oil to organisms residing in the Gulf). This logic is flawed because there are many mechanisms of toxicity that produce specific action at specific target sites (for example, as associated with organ development in embryos and larvae) beyond acute narcosis (narcosis causes relatively rapid death of an organism through depression or failure of neural or respiratory tissues). The actual toxicity derived from this methodology is underestimated because it is inferred from the measured concentrations of mixtures of compounds, in this case polycyclic aromatic hydrocarbons (PAHs) and the light aromatic hydrocarbons benzene, toluene, ethylbenzene and xylenes (BTEX), based on databases of acute toxicity levels of those individual compounds for aquatic organisms. There are many assumptions involved in drawing such inferences, but the most egregious is the assumption that death by narcosis is the only endpoint that is considered.

5.2. EPA Acute and Chronic Benchmarks were inappropriately used to draw conclusions that exposures were "safe" from actual or potential harm.

EPA's Water Quality Benchmarks for Aquatic Life reflect chemical concentrations that are derived primarily from short-term laboratory screening methods using lethality as an endpoint. This methodology was never intended as a means to assess real or potential harm from an oil spill. The EPA specifically notes that: "benchmarks are meant to be used for screening purposes only; they are not regulatory standards, site-specific cleanup levels, or remediation goals."[51] It was for such a screening purpose that EPA and USGS used this methodology in responding to the *Deepwater Horizon* incident.

The benchmark methodology used by Dr. Shea was actually derived from scientific guidance developed by EPA for managing sediments potentially contaminated with complex mixtures of polycyclic aromatic hydrocarbons (PAHs) in sediments during dredging or site remediation.[52] That guidance provides Equilibrium Partitioning Sediment Benchmarks (ESB values) that are derived for concentrations of PAH mixtures that will not adversely affect most benthic organisms. It was recognized that ESB values would have to be adjusted to account for future data and because of site-

[51] U.S. EPA Water Quality Benchmarks for Aquatic Life. http://www.epa.gov/bpspill/water-benchmarks.html#benchmarktable

[52] U.S. EPA (2003) Procedures for the Derivation of Equilibrium Partitioning Sediment Benchmarks (ESBs) for the Protection of Benthic Organisms: PAH Mixtures. EPA-600-R-02-013. Office of Research and Development, Washington, DC

specific considerations. Dr. Shea failed to take heed of the disclaimer in EPA's guidance document that: "in spill situations, where chemical equilibrium between water and sediments has not yet been reached, sediment chemical concentrations less that an ESB may pose risks to benthic organisms."

The primary flaw of using EPA benchmark methodology is that it is dependent only on narcotic response and does not consider other toxicity mechanisms. Hence other mechanisms such as embryo toxicity, site-specific mechanisms or process specific mechanisms are not considered. EPA has recognized this problem: "This approach is founded on an explicit assumption that the mechanism of toxic action determining ecological risk is non-polar narcosis. To the extent any other mechanisms of action are important, this approach would not address risks created by those other mechanisms of action."[53] Benchmark toxicity tests provide a reasonable estimate for lethal exposure levels, but because they do not take into account any of the other toxicity mechanisms, they are poor measures of toxicity potential in general, underestimate environmental risk, and will never provide a measure of a safe exposure level.[54] In fact, preliminary review of BP's own toxicity bioassays indicate that some species exhibited toxic effects at levels below the "safe" Toxic Unit of 1 used by Dr. Shea.

5.3. Toxicity data from which estimates were derived are based on testing of coastal species and not species living in the open ocean.

The EPA Water Quality Benchmark methodology relies on extensive databases of compound specific toxicity data for experimental animals that naturally live in freshwater or shallow coastal environments.[55] None of these test species lives in the offshore ecosystems of the Gulf of Mexico as defined in Dr. Boesch's expert report,[56] and only a few of these species reside in estuarine waters along the Gulf Coast. Again, using these benchmarks as a screening tool to differentiate toxicity potential between chemicals or different oils is appropriate, but using them as predictors in the environment is flawed, for many reasons, including the inappropriateness of the species tested. This is most egregious when considering the potential harm to the least known species in the deepwater habitats.

5.4. Statements that "fresh oil is more toxic than weathered oil" are not supported by contemporary literature.

This position reflects a misunderstanding of the weathering process and molecule toxicity, with the assumption by Dr. Shea that toxicity is caused primarily by the acute narcosis mechanism. Oil weathers because PAH molecules are differentially soluble

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[53] Letter from David R. Mount to Dr. Stanley Rice, Sept. 10, 2014, attached as Appendix B; *see also* US_PP_EPA045116-US_PP_EPA045120, US_PP_EPA045086 - US_PP_045090.

[54] The Mount letter also explains a math error in the EPA benchmark calculations that inadvertently doubled the acute concentrations of the benchmarks (in other words, the acute benchmarks should be half of what they are), the effect of which increases the numbers of samples exceeding the acute benchmarks. Dr. Shea was probably unaware of the math error.

[55] U.S. EPA (2003) Procedures for the Derivation of Equilibrium Partitioning Sediment Benchmarks (ESBs) for the Protection of Benthic Organisms: PAH Mixtures. EPA-600-R-02-013. Office of Research and Development, Washington, DC

[56] Boesch DF (2014) Expert Report: Actual and potential harm from the Macondo well blowout. United States of America.U.S. v BP Exploration & Production Inc. et al. United States District Court Eastern District of Louisiana MDL No. 2179, Section J, Washington, DC

and volatile; the more soluble or volatile, the more rapid the loss. The most soluble PAHs (generally the least toxic) leave oil droplets more readily that the larger, less soluble PAHs, but the less soluble PAHs are more toxic per molecule, increasing by approximately an order of magnitude as the number of rings increase.[57] As the more soluble compounds are lost, the remaining oil droplets contain higher concentrations of the more toxic compounds.[58] When considering acute narcosis toxicity mechanisms, as Dr. Shea does, the smaller more soluble compounds leave the droplets at a higher rate, and have a substantial influence on acute narcosis toxicity.[59] However, the 3- to 5-ringed PAHs are 1 to 4 orders of magnitude more toxic, persist for longer periods of time, and are the PAH compounds primarily responsible for the many specific toxicity mechanisms, even at lower concentrations of exposure. Substantial contemporary oil spill research (e.g. *Exxon Valdez* and *Cosco Busan* oil spills) indicates weathered oil is more toxic per unit volume because it contains relatively more persistent, hence higher-toxicity compounds.[60]

If toxicity were limited to acute narcosis mechanisms only, Dr. Shea would be correct that acute narcosis risk would decrease with weathering, as the loss of the most soluble compounds would decrease the bioavailability of the compounds most responsible for acute toxicity. However, weathered oil persists longer in the environment (higher concentrations of compounds resistant to degradation), with a higher concentration of the larger and more toxic compounds. These pose substantial toxicity potential to many different processes and mechanisms, from early life stages through adults.

5.5. The report lacks transparency as to the actual concentrations environmental concentrations and potency ratios estimated from samples.

Inferred toxicity based on chemical measurements are presented by Dr. Shea just in terms of whether the calculated TU is less than 1 ("safe for aquatic life") or greater than 1 ("exceed benchmark"). It is impossible to see either the actual measured contaminant concentrations or the computed TU levels and their distribution with regard to proximity to the blowout, depth in the water column, or time. No maps of concentration distributions are presented for either water or sediment and there is no accounting for the location of samples that do and do not match oil characteristics. Potency results (TU) are not mapped or otherwise plotted in sufficient detail. The kriging geostatistical model (Fig. 14 and Appendix I in Dr. Shea's report) provides little information and is reliant on threshold calculations. Such lack of transparency would

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[57] Neff JM, Stout SA, Gunster DJ (2005) Ecological risk assessment of polycyclic aromatic hydrocarbons in sediments: identifying sources and ecological hazard. Integrated Environonmental Assessment and Management 1: 2-33.

[58] Bence AE, Burns WA (1995) Fingerprinting hydrocarbons in the biological resources of the *Exxon Valdez* spill area. *Exxon Valdez* Oil Spill: Fate and Effects in Alaskan waters, Philadelphia, PA, ASTM STP 1219, American Society for Testing and Materials.

[59] Di Toro DM, McGrath, JA, et al. (2000) Technical basis for narcotic chemicals and polycyclic aromatic hydrocarbon criteria. I. Water and tissue. Environmental Toxicology and Chemistry 19: 1951-1970.

[60] Carls MG, Meador JP (2010) A perspective on the toxicity of petrogenic PAHs to developing fish embryos related to environmental chemistry. Human and Ecological Risk Assessment 15:1084-1098; Lundstedt S, White PA, Lemieux CL, Lynes KD, Lambert IB, Oberg L, Haglund P, Tysklind M (2007) Sources, fate, and toxic hazards of oxygenated polycyclic aromatic hydrocarbons (PAHs) at PAH-contaminated sites. Ambio 36:475-485; Vrabie CM, Sinnige TL, Murk AJ, Jonker MT (2012) Effect-directed assessment of the bioaccumulation potential and chemical nature of Ah receptor agonists in crude and refined oils. Environ Sci Technol 46:1572-1580.

be unacceptable for publication in a scientific journal; at a minimum such data would have to be provided in online supplementary materials.

5.6. Over-simplified statistics and graphics misrepresent the nature of exposure to hydrocarbon contaminants and thus real or potential harm.

In the same vein as the expert reports by Drs. Tunnell and Taylor, Dr. Shea's report attempts to trivialize the scale of contamination and effects by using graphics that relate the results to the large number of samples collected away from blowout or in portions of the water column where petroleum hydrocarbon contamination is unlikely. This is brought home in several rather pointless pie charts containing very slim or no slices.

In order to properly evaluate potential exposure, one has to understand the three-dimensional and temporal scope of the fate of hydrocarbons that resulted from this deepwater blowout and structure the analyses accordingly. This is for two critical reasons. Most importantly, as reviewed in the expert reports of Drs. Boesch and Rice,[61] toxic exposure was only likely to occur only where hydrocarbons were present, namely: (a) in the deepsea plume that was rich in dissolved light hydrocarbons and finely dispersed droplets; (b) within the near surface waters into which floating oil could be dissolved or be mixed; (c) at the seabed where oil was biodeposited and retained undispersed and relatively undegraded in sediments; and (d) in intertidal zones and shallow water habitats along the coast where the oil stranded. Secondly, the substantial majority of the 17,881 water samples to which Dr. Shea applies the Benchmark methodology were collected in none of those places, but in the water column somewhere between the deepwater plume and the top few meters of the water column. Relatively few of the samples came from within a few meters of the surface and none of the samples came from intertidal zones and shallow water habitats.

The NRDA water sampling was deliberate, to satisfy many objectives. The Trustees and BP did much of the water column testing cooperatively, and the work plans had specific data-gathering objectives for the sampling that included "looking for non-detects." For example, sampling was done in the middle of the water column as part of the subsea monitoring to ensure the deepwater plume of oil was not rising;[62] some sampling was done to collect baseline water samples close to shore from Texas to Florida to characterize conditions prior to the potential arrival of oil;[63] and much of the sampling done after August 3 was designed to support objectives of the OSAT teams in determining whether there remained actionable amounts of oil in the water after the well had been capped.[64] In other words, much of the water sampling was done

[61] Boesch DF (2014) Expert Report: Actual and potential harm from the Macondo well blowout. United States of America.U.S. v BP Exploration & Production Inc. et al. United States District Court Eastern District of Louisiana MDL No. 2179, Section J, Washington, DC, p. 27; Rice SD (2014) Expert Report: Toxicolgical impact of the MC252 Blowout, oil spill, and response. United States of America.U.S. v BP Exploration & Production Inc. et al. United States District Court Eastern District of Louisiana MDL No. 2179, Section J, Washington, DC), Section VI

[62] e.g., "Samples will also be taken in 3 reference locations outside the plume, in clear waters without surface oil while en-route to the area near the Wellhead." Water Column Injury Ephemeral Data Collections: Cruise 2: Surface Water Sampling Plan, available at www.gulfspillrestoration.noaa.gov.

[63] NRDA Plan for samples of opportunity in support of the Water Column baseline May 24, 2010, available at www.gulfspillrestoration.noaa.gov.

[64] "Due to the uncertainties in quantifying oil fate, it may not be possible to attain accountability for a significant amount of oil. Therefore, *it becomes imperative to sustain and expand the scope of our detection, sampling and*

primarily to confirm the absence of oil in water.[65] Additionally, as noted by the same NOAA scientists relied upon by Dr. Shea, sampling did not often occur in areas where dispersant applications were occurring—where the bioavailable oil would be expected to very high—due largely to the fact that teams were often too far away to arrive in time to monitor the impacts.[66] The failure to acknowledge the inherent limits of the data or to focus on the areas actually oiled are the reasons why Dr. Shea's chemistry and toxicology results are "not surprising" when he combines them all into one summary database.

Dr. Shea claims that his conclusions are conservative, but his presentation of the sample set is, in fact, biased because it underrepresents the portions of the environment that experienced the greatest exposure. The report emphasizes a gross summary result across time and space (i.e., his conclusion that only 1% of samples exceeded acute toxicity thresholds and 2% exceeded chronic toxicity thresholds) that obscures the location, depths and periods when oil was particularly toxic (deep plume and the upper few meters near the surface). A legitimate assessment therefore requires a time- and space-dependent analysis of the subject of interest (toxicity), not just simplistic summary statements and graphics that obscure locations and episodes of potential toxicity (Figure 6 in Dr. Shea's report). The level of that differentiation in Dr. Shea's report is just too crude. For example, nearly 10,000 water samples are reported coming from between the surface and 200 meters below the surface, even though it is logical that high concentrations would be found overwhelmingly in the top few meters.[67]

The primary objective should be to describe the spaces where and periods when elevated concentrations of hydrocarbons that could be toxic existed, not to bury this information within the ocean's vastness of uncontaminated seawater, much of it more than 100 km away from the site of the blowout. From our analyses of the NRDA database, we judge samples from the plume and from the upper surface to waters to be harmful (see Appendix A). For example, 26% of the plume samples were toxic in May as estimated by the EPA chronic threshold. Using the measured threshold of 0.5 ppb

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monitoring efforts to ensure that no harmful concentrations of oil and dispersants remain as a result of the spill and our response operations . . . This implementation strategy will deliver a comprehensive set of measures to clarify our understanding of the distribution and degradation of oil and dispersants in the water column, and identify any additional response requirements that may be necessary" (emphasis added). Sub-Sea and Sub-Surface Oil and Dispersant Detection, Sampling and Monitoring Strategy, 18 Aug 2010, TREX 9123.0101.

[65] "[The UAC Adaptive Sub-Surface Sampling Strategy Approved 043 Aug 2010] is your sustained sampling strategy to determine the presence *or absence* of sub-surface oil. Expansion of the scope and resources allocated for this purpose is necessary to support a more comprehensive plan for detecting, sampling, monitoring and providing information to the public" (emphasis added). Sub-Surface Oil and Dispersant Detection, Sampling and Monitoring Strategy Directive, 3 Aug 2010, TREX 9123.0098); "This cruise is part of a multi-phase effort to characterize *the potential extent and limits of oil* in the water column associated with the Deepwater Horizon (DWH) accident...[and] will develop additional data that are *needed to define changes or absence in the extent and concentration of both near-surface and sub-surface oil*, dissolved hydrocarbons, and dispersant" (emphases added). Deepwater Horizon Accident Broader Gulf of Mexico (BGOM) Water Column Sampling Study, BGOM Cruise 4 Work Plan, available at http://gulfsciencedata.bp.com/go/doc/6145/2213625/SRN-0145-WorkPlan-pdf.

[66] Bejarano AC, Levine E, Mearns AJ (2013) Effectiveness and potential ecological effects of offshore surface dispersant use during the Deepwater Horizon oil spill: a retrospective analysis of monitoring data. Environ Monit Assess 185:10281-10295 at 10283.

[67] Shea D (2014) Expert Report: In Re. Oil Spill by the Oil Rig "Deepwater Horizon" in the Gulf of Mexico, on April 20, 2010. BP Exploration and Production Inc. United States District Court, Eastern District of Louisiana, MDL No. 2179, Section J, New Orleans, LA, p. 26

PAH as harmful to bluefin tuna embryos,[68] at least 40% of the plume samples were toxic. Admittedly, bluefin tuna embryos are not found at that depth, but they are surrogates for embryos of other species. Surface water was the next most contaminated, with an EPA chronic estimate of 14% toxic levels in May (our analysis using the EPA threshold) and 33% toxic to bluefin tuna embryos and similarly sensitive species. These estimates are considerably greater than the 2% estimate provided by Dr. Shea, because they focus on where the oil was (deep plume and upper surface waters in the month of May).

5.7. The report does not consider processes by which sediments were contaminated by oily marine snow or documented impacts on bottom-dwelling organisms.

Peer-reviewed journal articles reviewed in Dr. Boesch's expert report provide strong evidence that one of the principal mechanisms causing sediment contamination in offshore ecosystems was the biodeposition of oily marine snow.[69] Although a central focus of Macondo well blowout research, the formation and deposition of oily marine snow is not mentioned at all in Dr. Shea's report, yet it substantially influences the nature of exposure to petroleum compounds for organisms living both in the water column and on the seabed. The concentration of petroleum compounds in these organic aggregates creates exposure conditions that are very different from the toxicity tests that underlie the Water Quality Benchmark approach applied by Dr. Shea. Deposition of oily marine snow added unusual amounts of organic matter as well as hydrocarbons (including PAH) to surface sediments and covered and killed epibiota such as coldwater corals. Documented sediment contamination had severe to moderate effects on animals living in bottom sediments over 57 square miles.[70] Long-term effects on coldwater corals have been attributed to covering by oily residues up to 13.6 miles from the Macondo well.[71] Yet, Dr. Shea chose not consider any of the field studies of biological effects at the seabed, but rather just drew inferences from sediment chemistry.

5.8. The potential influence of natural seeps is exaggerated.

Dr. Shea briefly: (a) mentions natural seeps as a source of oil contamination in the Gulf of Mexico; (b) indicates that they may discharge 1.27 million barrels of oil per year; and (c) suggests that some portion of oil-related chemicals measured in the water and sediment was the result of naturally occurring oil.[72] While he does not attempt to quantify the extent to which benchmark exceedences are attributable to these sources,

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[68] Incardona JP, Gardner LD, Linbo TL, Brown TL, Esbaugh AJ, Mager EM, Stieglitz JD, French BL, Labenia JS, Laetz CA, Tagal M, Sloan CA, Elizur A, Benetti DD, Grosell M, Block BA, Scholz NL (2014) Deepwater Horizon crude oil impacts the developing hearts of large predatory pelagic fish. Proc Natl Acad Sci USA 111:E1510-E1518

[69] Boesch DF (2014) Expert Report: Actual and potential harm from the Macondo well blowout. United States of America.U.S. v BP Exploration & Production Inc. et al. United States District Court Eastern District of Louisiana MDL No. 2179, Section J, Washington, DC, p. 17, 23

[70] Montagna PA, Baguley JG, Cooksey C, Hartwell I, Hyde LJ, Hyland JL, Kalke RD, Kracker LM, Reuscher M, Rhodes AC (2013) Deep-sea benthic footprint of the deepwater horizon blowout. PLoS One 8:e70540

[71] Fisher CR, Demopoulos AWJ, Cordes EE, Baums IB, White HK, Bourque JR (2014) Coral Communities as Indicators of Ecosystem-Level Impacts of the Deepwater Horizon Spill. BioScience 64:796-807

[72] Shea D (2014) Expert Report: In Re. Oil Spill by the Oil Rig "Deepwater Horizon" in the Gulf of Mexico, on April 20, 2010. BP Exploration and Production Inc. United States District Court, Eastern District of Louisiana, MDL No. 2179, Section J, New Orleans, LA, p. 11, 56-57

he includes possible contamination from natural seeps as a reason why his conclusions are conservative, overestimating the actual exposure and potential harm from the Macondo well blowout. As Dr. Shea points out there is a wide range of reported estimates of the total volume of oil released by natural seeps in the Gulf of Mexico. However, the discharge rates of natural seeps near the Macondo well were very likely orders of magnitude less than from the Macondo well blowout.[73] And, the slow releases of these seeps do not produce massive plumes of dispersed oil droplets; there is neither the dispersant assistance nor the turbulent mixing cause by high-pressure release as the high-volume discharge from the Macondo well. Otherwise, there would be a perpetual deepsea plume and a perpetual massive surface oil slick in the region and neither has been observed.

5.9. The report fails to consider extensive germane peer-reviewed literature, some of which presents results or draws conclusions that contradict its conclusions.

The broader peer-reviewed literature is largely ignored, including the experimental studies demonstrating not only the toxic effects of PAH at lower concentrations in fish embryos, larvae and juveniles,[74] but also: bioaccumulation of PAHs and other hydrocarbons in plankton;[75] mortality experienced by animals living in association with floating *Sargassum*;[76] deposition of oily marine snow on sediment and coral habitats;[77] and PAH metabolites and lesions in bottom-dwelling fish.[78]

Dr. Shea relies on his analyses of PAH measurements in the water, compares to the EPA acute toxicity benchmarks, and ignores the advances in oil spill science from the last 20 years and from the DWH spill. During this time, research has advanced from the consideration of carcasses and acute toxicity, to a more sophisticated understanding of oil spill damage, oil persistence, toxicity potential, and long term effects from spills. The emerging DWH studies continue to add to that understanding.

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[73] McNutt MK, Camilli R, Crone TJ, Guthrie GD, Hsieh PA, Ryerson TB, Savas O, Shaffer F (2012) Review of flow rate estimates of the Deepwater Horizon oil spill. Proc Natl Acad Sci USA 109:20260-20267

[74] Incardona JP, Gardner LD, Linbo TL, Brown TL, Esbaugh AJ, Mager EM, Stieglitz JD, French BL, Labenia JS, Laetz CA, Tagal M, Sloan CA, Elizur A, Benetti DD, Grosell M, Block BA, Scholz NL (2014) Deepwater Horizon crude oil impacts the developing hearts of large predatory pelagic fish. Proc Natl Acad Sci USA 111:E1510-E1518 Dubansky B, Whitehead A, Miller JT, Rice CD, Galvez F (2013) Multitissue molecular, genomic, and developmental effects of the Deepwater Horizon oil spill on resident Gulf killifish (*Fundulus grandis*). Environ Sci Technol 47:5074-5082 Mager EM, Esbaugh AJ, Stieglitz JD, Hoenig R, Bodinier C, Incardona JP, Scholz NL, Benetti DD, Grosell M (2014) Acute embryonic or juvenile exposure to Deepwater Horizon Crude oil impairs the swimming performance of Mahi-Mahi (*Coryphaena hippurus*). Environ Sci Technol 48:7053-7061

[75] Mitra S, Kimmel DG, Snyder J, Scalise K, McGlaughon BD, Roman MR, Jahn GL, Pierson JJ, Brandt SB, Montoya JP, Rosenbauer RJ, Lorenson TD, Wong FL, Campbell PL (2012) Macondo-1 well oil-derived polycyclic aromatic hydrocarbons in mesozooplankton from the northern Gulf of Mexico. Geophys Res Lett 39:L01605

[76] Powers SP, Hernandez FJ, Condon RH, Drymon JM, Free CM (2013) Novel pathways for injury from offshore oil spills: direct, sublethal and indirect effects of the Deepwater Horizon oil spill on pelagic Sargassum communities. PLoS One 8:e74802

[77] Montagna PA, Baguley JG, Cooksey C, Hartwell I, Hyde LJ, Hyland JL, Kalke RD, Kracker LM, Reuscher M, Rhodes AC (2013) Deep-sea benthic footprint of the deepwater horizon blowout. PLoS One 8:e70540; Fisher CR, Demopoulos AWJ, Cordes EE, Baums IB, White HK, Bourque JR (2014) Coral Communities as Indicators of Ecosystem-Level Impacts of the Deepwater Horizon Spill. BioScience 64:796-807

[78] Murawski SA, Hogarth WT, Peebles EB, Barbeiri L (2014) Prevalence of external skin lesions and polycyclic aromatic hydrocarbon concentrations in Gulf of Mexico fishes, post-Deepwater Horizon. Trans Am Fish Soc 143:1084-1097

5.10. Definitive conclusions related to harm are unsupported, highly speculative and premature.

The Shea report is unpersuasive because it attempts to use EPA benchmark screening procedures to compare with measured water concentrations of PAH, arriving at the conclusion that there was little chance of exposure and thus little chance of harm. The primary flaw is that the EPA benchmark methodology relies primarily on acute toxicity narcosis as the toxicity mechanism, and dismisses many other toxicity mechanisms, along with dismissing the evolution of spill science over the last two decades. By relying on the benchmark methodology and acute narcosis, the Shea report finds little evidence of toxicity potential, despite the fact that this is the largest release of oil in US waters, over an extended period of time, with conditions that were optimal for making dispersions of small droplets of oil for increased probability of exposure to organisms living in the Gulf of Mexico (bioavailablity). The report trivializes exposure potential in three ways: first by using all of the measured water measurements which includes areas not in the oil trajectory, second by not considering time dependent change in concentration, and third by using an inappropriate EPA benchmark standard, arriving at a possible exposure of less than 2% of the 18,000 samples taken.

In contrast, Dr. Rice's report concludes there was significant toxicity potential. Toxic oil concentrations were patchy, over time and geography, but because of the unique aspects of this blowout (dispersed oil released for nearly 3 months), there was ample opportunity for the most sensitive life stages (embryos, larvae) of many species to have encounters with concentrations of PAH above 0.5 ppb that were likely to be harmful. There is considerable support for that position, from prior oil spills and from the literature on the Macondo well blowout that continues to emerge.

6. CONCLUSIONS

6.1. Conclusions concerning harm to Gulf ecosystems and resources are not based on direct measurements of actual or potential harm and are at least premature.

Whether it be broad fish and shellfish abundance data, fishery landings, shore-based bird counts, shoreline oiling observed during spill response, or chemical contaminant concentrations in water and sediment samples, the primary metrics used in the four BP expert reports do not directly or comprehensively measure harm to the Gulf of Mexico's ecosystems and biological resources. While some of the analyses presented are derived from the Natural Resources Damage Assessment, there are extensive NRDA data that were not considered and are still being interpreted by the Natural Resource Trustees as well as by the responsible parties. In addition, the Gulf of Mexico Research Program (GoMRI) that is funded by BP but independently managed continues to yield new peer-reviewed articles that are relevant to assessing actual or potential harm virtually every week. In that context, at the very least, sweeping conclusions that any environmental harm was limited, relatively inconsequential and short-lived must be regarded as highly speculative and premature.

6.2. The reports fail to consider all evidence of impacts, neglecting some vulnerable ecosystems and electing not to consider the relevant peer-reviewed literature.

There are glaring omissions in consideration of the growing body of knowledge on effects of the Macondo well blowout, notably of publications that document or strongly suggest biological effects. Many of these publications result from NRDA or BP-sponsored GoMRI studies. For example, little or no mention is given to the effects on floating *Sargassum* communities; deepwater benthic communities, including cold-water corals; fish embryos and larvae; bottom-dwelling adult fishes; and marine mammals and sea turtles.

6.3. Sweeping conclusions are drawn based on flawed analyses of selective data.

As we have pointed out, the various expert reports over-extend conclusions based on data that the experts have chosen without fully disclosing critical assumptions and limitations (e.g., limited power and complicating factors in detecting change in fisheries survey and landings data; over-interpretation of shoreline response surveys (SCAT) in determination of environmental effects; and reliance on bioassays that reflect only narcotic effects and not specific toxicity). Furthermore, the use of some of the tools used in data analysis (e.g. linear regression for change detection) is seriously flawed.

6.4. The extent of harm is concealed or diminished by presenting results in the context of large regions not affected by oil contamination.

Essentially, the reports, each in their own way, posited the "straw man" that for harm to be serious it would have to extend over virtually the whole of the U.S. Gulf of Mexico and be dramatically obvious: fishery landings for the whole region would have to crash; most of 4,000 miles of shoreline surveyed wound have to be oiled; toxic concentrations would have to be observed throughout the water column and hundreds of kilometers away. This, then, is an easy straw man to knock down, but it is one divorced from the reality of the scope of this blowout, which while enormous by any comparative oil-spill standard, still extended over just a portion of the vast Gulf of Mexico. The supposition that the effects would to be so extensive and obvious is inconsistent with what we know about the effects of oil spills and is as outrageous as the apocalyptic fears and claims of those on the other side.

6.5. For these reasons, the BP expert reports in no way demonstrate that actual and potential harm was not serious or long-term.

The matter before us in the Penalty Phase in this trial, as we understand it, is whether the actual or potential harm was serious. For the reasons detailed throughout our response and summarized in the above four points, the BP expert reports fall far short of establishing that the environmental harm was other than very serious. The broader body of knowledge, which is still evolving, demonstrates that some of the Gulf's ecosystems and biological resources were seriously harmed and that, in some cases, that harm continues to this day. The extent and consequences of this harm will become better resolved through the Natural Resources Damage Assessment and the remaining years of the BP-sponsored Gulf of Mexico Research Initiative.

Appendix A

Estimation of toxic potential in DWH water samples.

1. Samples were obtained from "BP Gulf Science Data (NRDA-publicly available)," file name "WaterChemistry_W-01v02-01.csv" dated 5/23/2014.
2. The CSV file was too long to read directly with Excel, thus was subdivided into several files.
3. All 2010 data were extracted into Excel.
4. PAH data were assembled to yield one record per sample. Samples were identified by "Laboratory sample ID." This resulted in 15,114 samples.
5. Polynuclear aromatic hydrocarbon (PAH) analytes are listed below. Not all of these were measured in every sample. ND concentrations were 0.

N0	D0	PYR	BBF
N1	D1	FP1	BKF
N2	D2	FP2	BEP
N3	D3	FP3	BAP
N4	P0	FP4	PER
ACN	P1	BAA	ICP
ACE	P2	C0	DBA
F0	P3	C1	BZP
F1	P4	C2	
F2	ANT	C3	
F3	FLU	C4	

6. Concentrations were summed to yield total PAH (TPAH). Data were analyzed by month, depth, and location (Fig. 1).
7. The EPA threshold method was applied to each water sample. The acute version was corrected per discussion with Dr. David Mount, one of the original EPA authors. All alkylated PAHs were included in the model, thus no alkyl-adjustment multipliers were required (Fig. 2).
8. Alternative estimations of toxicity were based on Gulf of Mexico larval fish assays: (Incardona et al. 2014) reported threshold TPAH concentrations as low as 0.3 μg/L. Numbers of samples above this threshold (and several other comparison values, 0.5, 1, and 2 μg/L) were summed by month to calculate the fraction toxic (per month, depth, and location) (Fig. 3a-d).
9. To estimate fractions toxic within the slick area only, data were plotted by month with ArcMap along with satellite slick information (SAR). Offshore samples within polygons bounding the slick area were identified with ArcMap (Fig. 4).
10. The toxic fraction in the offshore surface water (0 –2 m) within slick boundaries was estimated for May through July with the TPAH concentration method described in step 8 (Figs. 5 - 6).
11. It should be noted that this analysis is not intended to be a quantitative assessment of the extent of oil contamination in the Gulf. That is more properly a part of the NRD Assessment, which is still ongoing and may employ additional data and methods of analysis. The purpose of this exercise is simply to point out that Dr. Shea's opinion regarding the extent of toxic concentrations of PAHs in the Gulf is misleading because it fails to employ the appropriate

toxicological thresholds and fails to focus on the areas and times when high concentrations of PAHs were likely to occur.

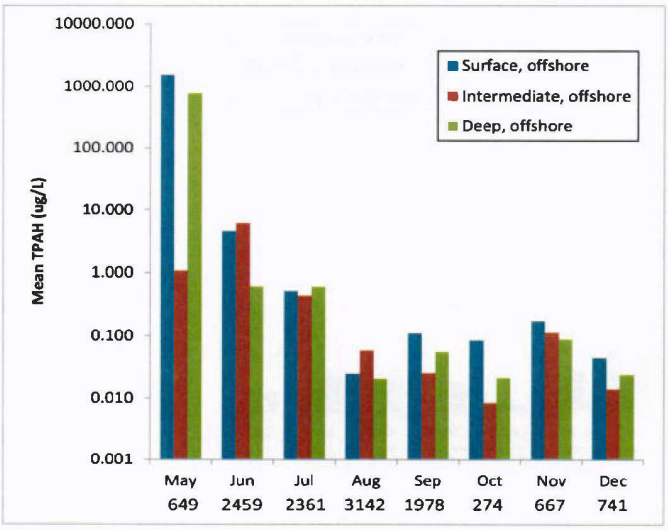
Roughly one quarter of the samples were collected nearshore; the remainder were collected offshore.

	n offshore	*n* Total	%nearshore	%offshore
May	649	650	0.2	99.8
Jun	2459	2942	16.4	83.6
Jul	2361	2824	16.4	83.6
Aug	3142	3569	12.0	88.0
Sep	1978	2448	19.2	80.8
Oct	274	778	64.8	35.2
Nov	667	934	28.6	71.4
Dec	741	969	23.5	76.5

Within the offshore data set, about one quarter of the samples were from the surface (upper 2 m), one quarter were from plume depths (≥1000 m), and the remaining half were from elsewhere in the water column.

	n Surface	n Plume	%surface	%Plume	% other
May	129	198	19.9	30.5	49.7
Jun	745	620	30.3	21.1	48.6
Jul	749	726	31.7	25.7	42.6
Aug	739	1062	23.5	29.8	46.7
Sep	373	721	18.9	29.5	51.7
Oct	98	23	35.8	3.0	61.3
Nov	163	219	24.4	23.4	52.1
Dec	135	377	18.2	38.9	42.9

Fig. 1. Mean total aqueous PAH concentration by month. Surface is ≤ 2 m, deep is ≥ 1000 m and intermediate is all depths between. The total number of samples analyzed each month for offshore and nearshore sets is listed along the x-axis.



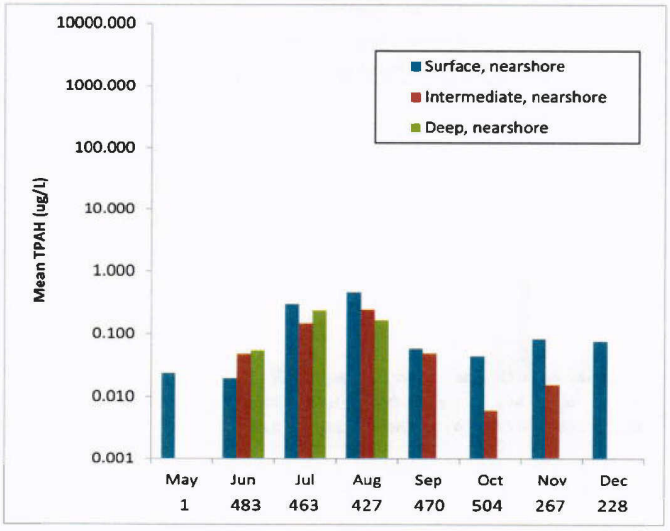
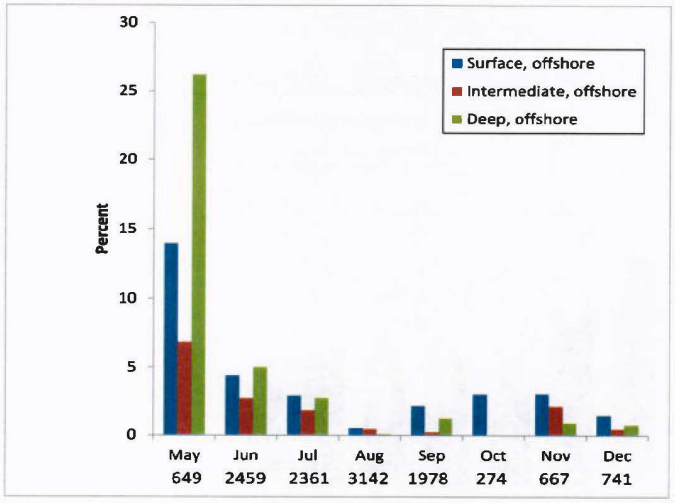


Fig. 2. Percent of samples exceeding EPA toxicity threshold for water samples as a function of time using the EPA threshold method (chronic toxicity).



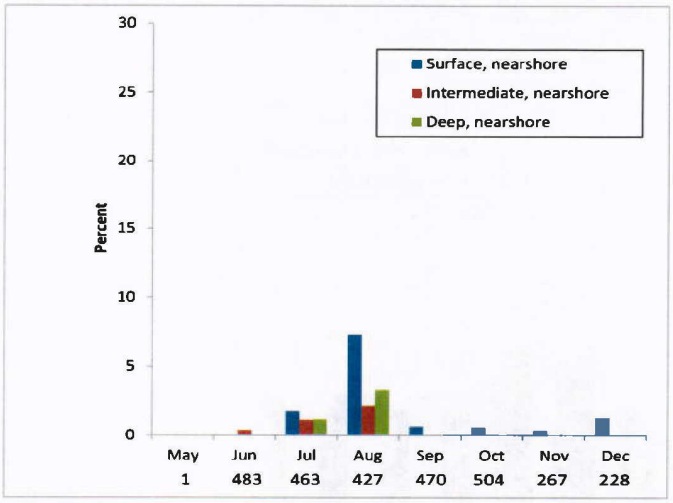
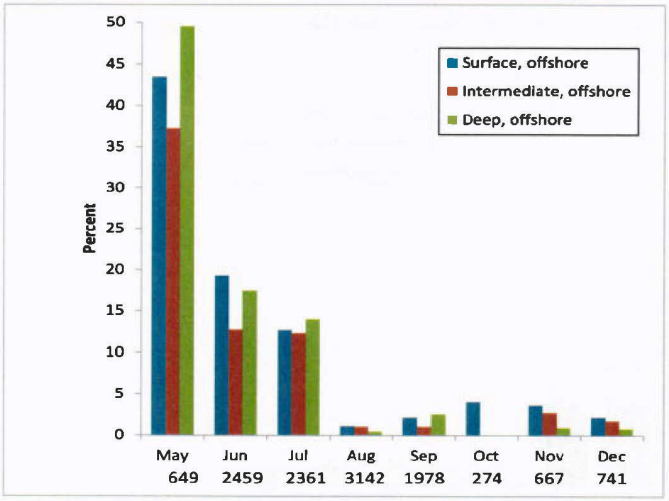


Fig. 3a. Percent of water samples as a function of time that exceed toxicity threshold using embryo sensitivity estimates: 0.3 µg/L. Estimated embryo toxicity thresholds were as low as 0.3 for bluefin tuna and were between 1 and 6 µg/L for amberjack (Incardona et al. 2014).



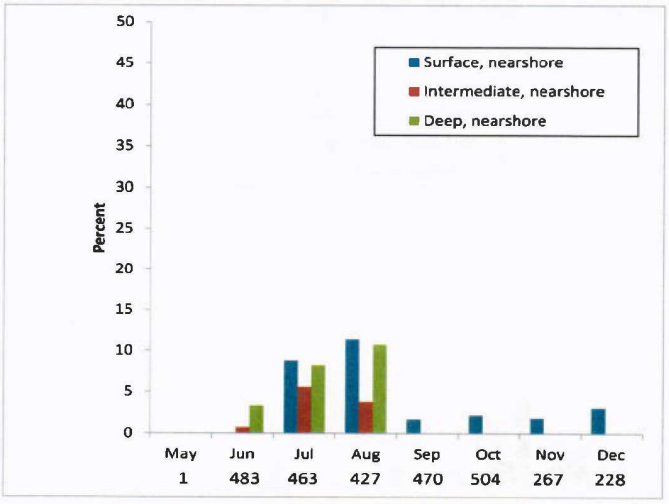
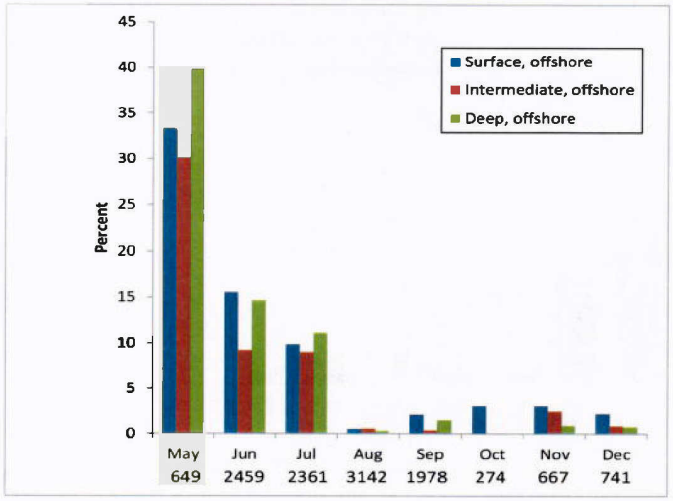


Fig. 3b. Percent of water samples as a function of time that exceed toxicity threshold using embryo sensitivity estimates: 0.5 µg/L. Estimated embryo toxicity thresholds were as low as 0.3 for bluefin tuna and were between 1 and 6 µg/L for amberjack (Incardona et al. 2014).



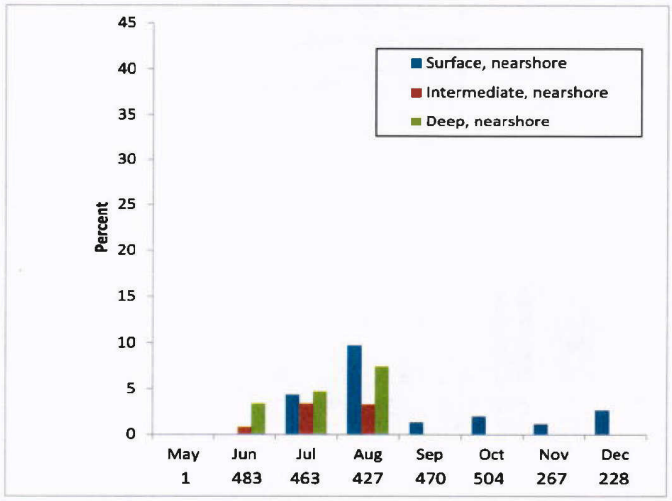
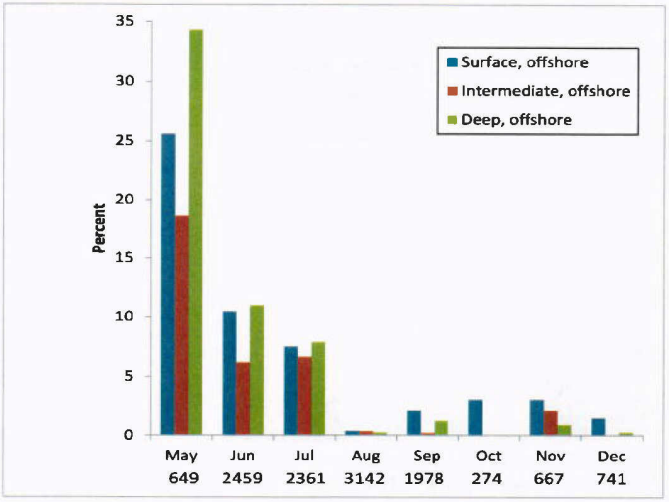


Fig. 3c. Percent of water samples as a function of time that exceed toxicity threshold using embryo sensitivity estimates: 1.0 µg/L. Estimated embryo toxicity thresholds were as low as 0.3 for bluefin tuna and were between 1 and 6 µg/L for amberjack (Incardona et al. 2014).



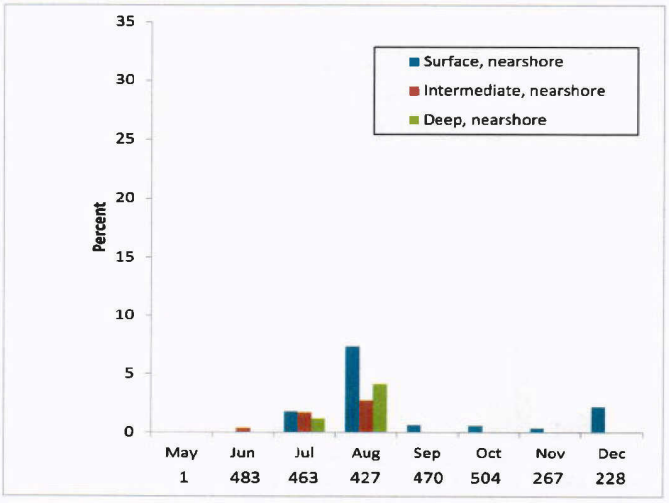
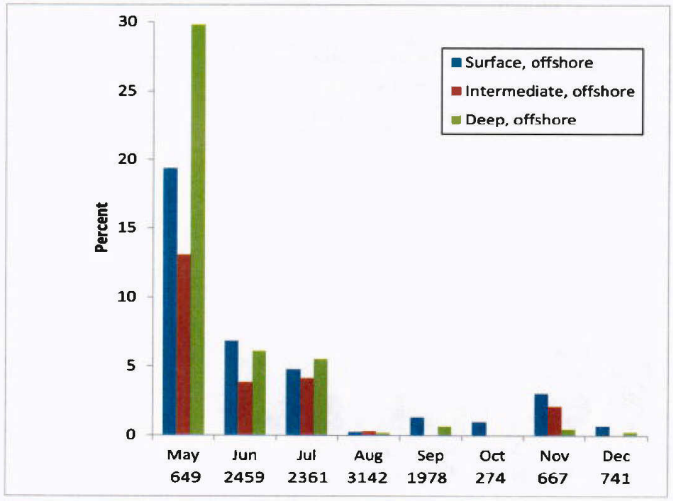


Fig. 3d. Percent of water samples as a function of time that exceed toxicity threshold using embryo sensitivity estimates: 2.0 µg/L. Estimated embryo toxicity thresholds were as low as 0.3 for bluefin tuna and were between 1 and 6 µg/L for amberjack (Incardona et al. 2014).



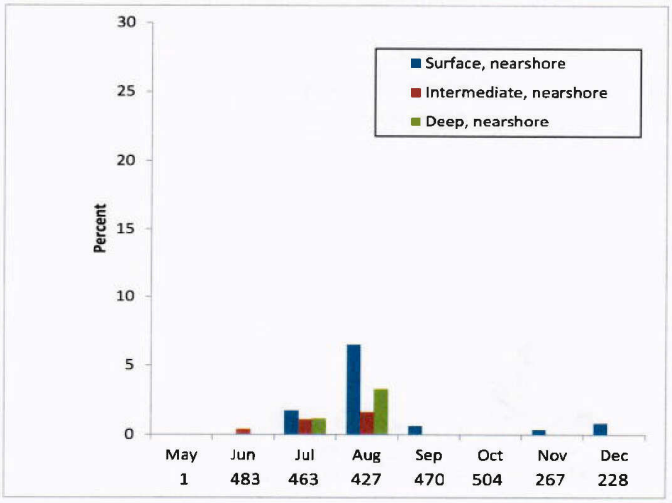


Fig. 4. Offshore samples within slick areas were defined as those within the slick boundaries identified by satellite (dark grey). Samples to the west of the primary slick boundary in June were not included as "within."

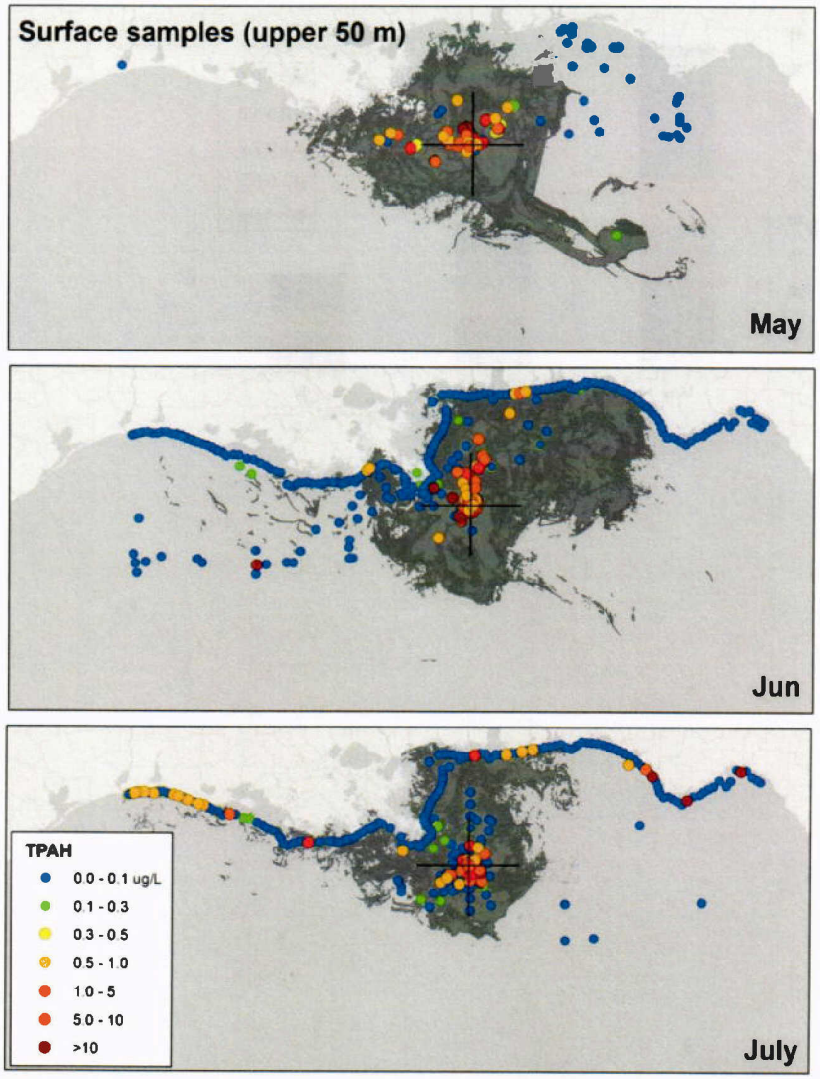


Fig. 5. Toxicity estimate in surface water (0 – 2 m) within the slick area only during the time the slick was present (May – July). Total slick area was determined by satellite and composited by month.

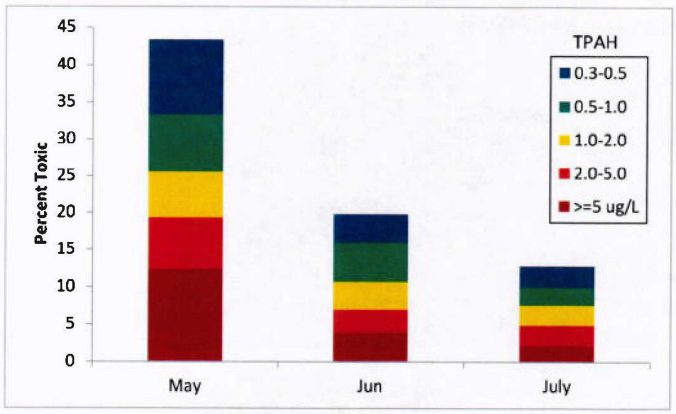
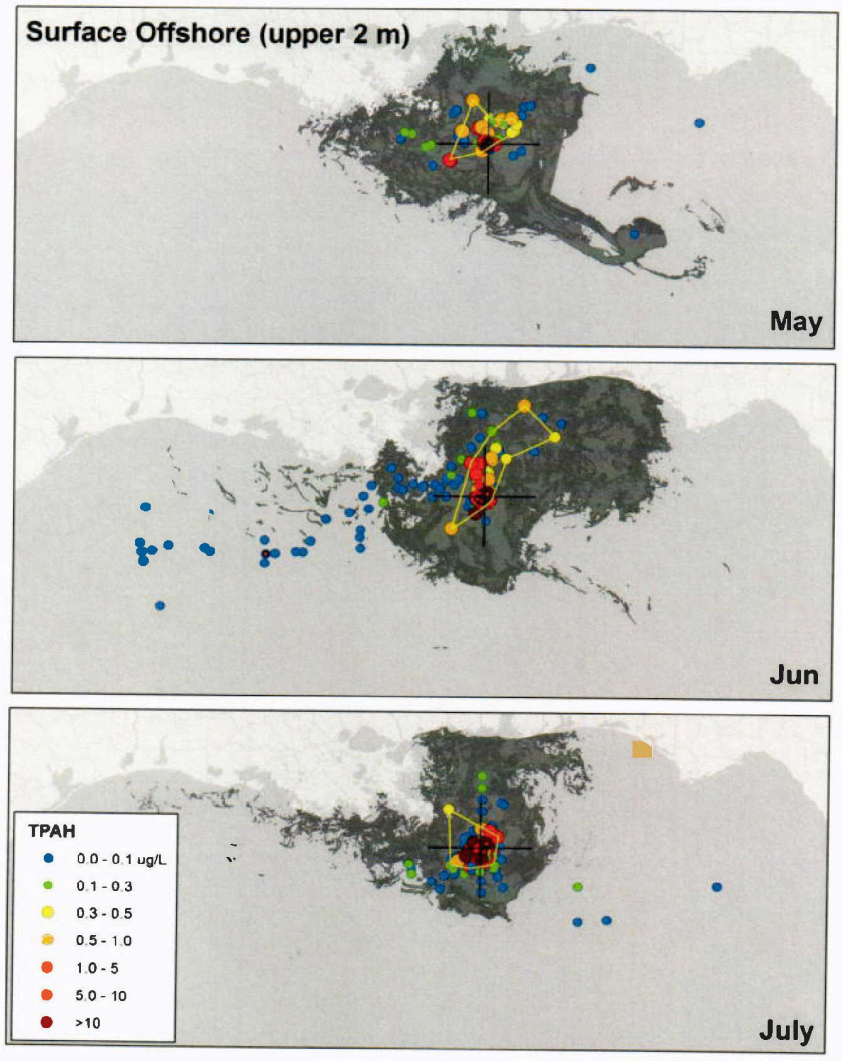


Fig. 6. Offshore surface water samples only. Surface is defined as the upper 2 meters. Yellow polygons bound observed area with toxic concentrations (at 0.3 µg/L). These areas are 5460, 12131, and 6225 km^2.



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Incardona, J. P., L. D. Gardner, et al. (2014). "Deepwater Horizon crude oil impacts the developing hearts of large predatory pelagic fish." Proceedings of the National Academy of Sciences of the United States of America **www.pnas.org/cgi/doi/10.1073/pnas.1320950111**: E1510–E1518.

Appendix B

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
NATIONAL HEALTH AND ENVIRONMENTAL EFFECTS
RESEARCH LABORATORY
MID-CONTINENT ECOLOGY DIVISION
6201 CONGDON BOULEVARD • DULUTH, MINNESOTA 55804-2595

OFFICE OF
RESEARCH AND DEVELOPMENT

September 10, 2014

MEMORANDUM

SUBJECT: Background on the process used to develop narcosis-based screening benchmarks used to interpret analysis of environmental samples following the BP Deepwater Horizon oil spill

FROM: David R. Mount

TO: Dr. Stanley Rice

This memorandum provides details and background on the methodology I used to develop narcosis-based screening benchmarks that were subsequently used to interpret the chemical analysis of environmental samples following the BP Deepwater Horizon oil spill. I also comment on an error in that original derivation which I recently noticed in the context of explaining the derivation of these values.

Outline of the technical basis:

1. My primary source for the analysis was an EPA document, Procedures for the Derivation of Equilibrium Partitioning Sediment Benchmarks (ESBs) for the Protection of Benthic Organisms: PAH Mixtures (EPA-600-R-02-013). I supplemented this source with information from DiToro et al. (2000a,b; cited in the above document).
2. My conceptual approach was to estimate values for PAH mixtures that would be similar to EPA acute and chronic water quality criteria in their derivation.
3. For most of the compounds under consideration, the polycyclic aromatic hydrocarbons or PAHs, I used the approach contained within the ESB document. For monocyclic aromatic compounds, however, I supplemented the analysis with information from Di Toro et al. (2000a,b).
4. This approach is founded on an explicit assumption that the mechanism of toxic action determining ecological risk is non-polar narcosis. To the extent any other mechanisms of action are important, this approach would not address risks created by those other mechanisms of action.
5. In cases where only unsubstituted "parent" or "priority pollutant" PAHs were measured, I developed estimates of the expected additional effects of unmeasured alkylated PAHs using the reported composition of a tar ball believed at the time to be from the Deepwater Horizon event, referred to as the "Dauphin Island tar ball." To

the extent the resulting guideline was applied to oil-contaminated samples with a different composition, this assumption could lead to inaccuracies.

6. The ESB approach requires organic carbon normalization for evaluating sediment contamination. To address situations where organic carbon content of sediment was not measured, I used an assumption of 1% organic carbon, which is a common default assumption in sediment assessment, but its accuracy could vary widely as individual sediments are known to range well beyond 0.1% to 10%.

About a month ago, I discovered an error in my calculation of the acute benchmarks. Specifically, to develop an "acute benchmark", I used the Final Acute Value (the 5th percentile of the distribution of LC50 values for individual species) directly. This is not how the Final Acute Value should be used in estimating an "acute criterion" in water quality criteria derivation. As explicitly stated in the EPA guidelines for deriving water quality criteria (http://water.epa.gov/scitech/swguidance/standards/upload/2009_01_13_criteria_85guidelines.pdf) the "acute criterion" (criterion maximum concentration) is established as the Final Acute Value divided by 2. This division by 2 is included with the intent of reducing the severity of effect at the 5th percentile of the sensitivity distribution from a high level of effect (50% mortality) to only a limited acute effect. So, if properly implemented, the Acute Effect Benchmarks should have been established at one-half of the values contained in the spreadsheets I developed at the time. The chronic effect benchmarks are unaffected by this error.

Appendix C

Sources Considered
(In addition to the documents cited in our Round 1 reports and this expert report, as well as the consideration materials identified in conjunction with our Round 1 expert reports)

Bates, Exhibit, TREX, or Other Description
ANA-MDL-000264843-ANA-MDL-000264448
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Sources Considered

(In addition to the documents cited in our Round 1 reports and this expert report, as well as the consideration materials identified in conjunction with our Round 1 expert reports)

Bates, Exhibit, TREX, or Other Description
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Sources Considered
(In addition to the documents cited in our Round 1 reports and this expert report, as well as the consideration materials identified in conjunction with our Round 1 expert reports)

Bates, Exhibit, TREX, or Other Description
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Sources Considered

(In addition to the documents cited in our Round 1 reports and this expert report, as well as the consideration materials identified in conjunction with our Round 1 expert reports)

Bates, Exhibit, TREX, or Other Description
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Sources Considered
(In addition to the documents cited in our Round 1 reports and this expert report, as well as the consideration materials identified in conjunction with our Round 1 expert reports)

Bates, Exhibit, TREX, or Other Description
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CORRECTED Expert Report of Damian Shea
CORRECTED Expert Report of Wes Tunnell
DEFEXP024334-DEFEXP024346
DEFEXP024347-DEFEXP024361
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DEFEXP024983-DEFEXP024990
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Sources Considered
(In addition to the documents cited in our Round 1 reports and this expert report, as well as the consideration materials identified in conjunction with our Round 1 expert reports)

Bates, Exhibit, TREX, or Other Description
DEFEXP025007-DEFEXP025007
DEFEXP025008-DEFEXP025026
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Deposition Exhibit 12484
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Deposition Exhibit 12628
Deposition Exhibit 13003
Deposition Exhibit 13004
Deposition Exhibit 13005
Deposition Exhibit 13006
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Deposition Exhibit 13014
Deposition Exhibit 13015
Deposition Exhibit 13018
Deposition Exhibit 13019
Deposition Exhibit 13021
Deposition Exhibit 13023
Deposition Exhibit 9182
Deposition of Austin, RADM Meredith (July 17, 2014)
Deposition of Hein, CAPT Julia (July 9, 2014)
Deposition of Huston, Mark (June 24, 2014)
Deposition of Kulesa, Frank (July 15, 2014)

Sources Considered
(In addition to the documents cited in our Round 1 reports and this expert report, as well as the consideration materials identified in conjunction with our Round 1 expert reports)

Bates, Exhibit, TREX, or Other Description
Deposition of Merten, Dr. Amy Ann (June 11, 2014)
Deposition of Michel, Dr. Jacqueline (August 1, 2014)
Deposition of Miller, Mark (July 10, 2014)
EET046-000026-EET046-000052
Expert Report of Donald F. Boesch, Actual and Potential Harm from the Macondo Well Blowout
Expert Report of Elliott Taylor
Expert Report of Frank M. Paskewich
Expert Report of Stanley D. Rice, Toxicological Impact of the MC252 Blowout, Oil Spill, and Response
HCE058-001529-HCE058-001532
IGS012-001033-IGS012-001038
LAD044-010903-LAD044-010906
N7X010-000026-N7X010-000046
N9G007-000107-N9G007-000121
OSE189-005546-OSE189-005596
OSE208-023249-OSE208-023252
PNL001-018800-PNL001-018883
PPDEPODOC022037-PPDEPODOC022045
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PPDEPODOC022776-PPDEPODOC022825
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TREX-000769
TREX-009105
TREX-009105

Sources Considered
(In addition to the documents cited in our Round 1 reports and this expert report, as well as the consideration materials identified in conjunction with our Round 1 expert reports)

Bates, Exhibit, TREX, or Other Description
TREX-009123
TREX-009124
TREX-009182
US_PP_DBO000065-US_PP_DBO000099
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US_PP_DBO001604-US_PP_DBO001639
US_PP_DBO001640-US_PP_DBO001710
US_PP_DBO001711-US_PP_DBO001787
US_PP_DBO002321-US_PP_DBO002328
US_PP_DBO004603-US_PP_DBO004612
US_PP_DBO004979-US_PP_DBO004988
US_PP_DBO006461-US_PP_DBO006600

Sources Considered
(In addition to the documents cited in our Round 1 reports and this expert report, as well as the consideration materials identified in conjunction with our Round 1 expert reports)

Bates, Exhibit, TREX, or Other Description
US_PP_DBO007297-US_PP_DBO007298
US_PP_DBO007299-US_PP_DBO007314
US_PP_DBO007315-US_PP_DBO007315
US_PP_DBO007316-US_PP_DBO007343
US_PP_DBO007344-US_PP_DBO007350
US_PP_DBO007351-US_PP_DBO007361
US_PP_DBO007362-US_PP_DBO007368
US_PP_DBO007369-US_PP_DBO007369
US_PP_DBO007370-US_PP_DBO007379
US_PP_DBO007388-US_PP_DBO007398
US_PP_DBO007399-US_PP_DBO007407
US_PP_DBO007408-US_PP_DBO007408
US_PP_DBO007409-US_PP_DBO007421
US_PP_DBO007422-US_PP_DBO007433
US_PP_DBO007434-US_PP_DBO007444
US_PP_DBO007445-US_PP_DBO007451
US_PP_DBO007452-US_PP_DBO007460
US_PP_DBO007461-US_PP_DBO007494
US_PP_DBO007495-US_PP_DBO007510
US_PP_DBO007511-US_PP_DBO007518
US_PP_DBO007519-US_PP_DBO007526
US_PP_DBO007527-US_PP_DBO007534
US_PP_DBO007535-US_PP_DBO007541
US_PP_DBO007542-US_PP_DBO007547
US_PP_DBO007548-US_PP_DBO007550
US_PP_DBO007551-US_PP_DBO007558
US_PP_DBO007559-US_PP_DBO007571
US_PP_DBO007572-US_PP_DBO007583
US_PP_DBO007584-US_PP_DBO007591
US_PP_DBO007592-US_PP_DBO007602
US_PP_DBO007603-US_PP_DBO007609
US_PP_DBO007610-US_PP_DBO007784
US_PP_DBO007785-US_PP_DBO007788
US_PP_DBO007789-US_PP_DBO007916
US_PP_DBO007917-US_PP_DBO007919
US_PP_DBO007920-US_PP_DBO007925
US_PP_DBO007926-US_PP_DBO007937
US_PP_DBO007938-US_PP_DBO007946
US_PP_DBO007947-US_PP_DBO007947
US_PP_DBO007948-US_PP_DBO007958
US_PP_DBO007959-US_PP_DBO007959

Sources Considered
(In addition to the documents cited in our Round 1 reports and this expert report, as well as the consideration materials identified in conjunction with our Round 1 expert reports)

Bates, Exhibit, TREX, or Other Description
US_PP_EPA045086-US_PP_EPA045088
US_PP_EPA045089-US_PP_EPA045090
US_PP_EPA045116-US_PP_EPA045119
US_PP_EPA045120-US_PP_EPA045130
US_PP_EPA045131-US_PP_EPA045149
US_PP_EPA045150-US_PP_EPA045165
US_PP_EPA045166-US_PP_EPA045173
US_PP_EPA045174-US_PP_EPA045181
US_PP_EPA045182-US_PP_EPA045189
US_PP_EPA045190-US_PP_EPA045196
US_PP_EPA045197-US_PP_EPA045204
US_PP_NOHD15024362-US_PP_NOHD15024363
US_PP_RICE005054-US_PP_RICE005054
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US_PP_USACE247191-US_PP_USACE247221