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

REBUTTAL TO BP ROUND 2 REPORTS

Submitted on Behalf of the United States

Prepared by: Donald F. Boesch (Ph.D.)

Donald F. Boesch (Ph.D.)

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1. SUMMARY CONCLUSIONS

This report, prepared for the United States, includes my responses to six Round 2 Reports that addressed my opening Round 1 Report on the Actual and Potential Harm from the Macondo Well Blowout.[1] The six Round 2 Reports were prepared by the following experts engaged by BP: Dr. John R. Tunnell; Joseph M. Geraci, V.M.D.; Ph.D., Dr. Loren Scott; Elliott Taylor, Ph.D.; Frank Paskewich, Capt., USCG (Ret.); and Dr. Damien Shea.[2] In this report I have replied in detail to their numerous specific points rebutting my Round 1 Report. Based on these considerations as well as those made in a Round 2 Report that I prepared together with Dr. Stanley Rice rebutting the Round 1 Expert Reports by Drs. Tunnell, Taylor, and Shea and Capt. Paskewich, I draw the following conclusions:

a) The BP Round 2 Reports do not raise valid criticisms or new evidence that would require me to alter the conclusions of my opening Round 1 Report.

b) The BP Round 2 Reports also do not resolve the criticisms raised in the U.S. Round 2 Report pertaining to the BP Round 1 Reports.

c) While the BP Round 2 Reports now address some of the important ecosystems and living resources omitted in the BP Round 1 Reports, weaknesses in their arguments reinforce my original conclusions.

d) The evidence presently available in the scientific community supports a conclusion that the actual and potential harm caused by the Macondo well blowout was serious; however, the full quantification of that harm remains to be determined.

2. COMMON REPLIES TO THE BP ROUND 2 REPORTS

2.1. The BP experts' Round 2 Reports continue to attempt to draw definitive conclusions of no or minimal harm that prejudge the ongoing Natural Resources Damage Assessment.

This consistent strategy in BP's opening Round 1 Reports that Dr. Rice and I criticized (Boesch and Rice Round 2 Report, p. 6, 14, 19, and 27) continues in the BP Round 2 Reports. However, the efforts of the BP experts to refute my report and the peer-reviewed literature on which it is based have become somewhat more extreme.

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[1] Throughout this the various reports are referred to as Round 1 (exchanged on August 15, 2014) opening reports and Round 2 (exchanged on September 12, 2014) response reports. The present report is one of the third and final round of expert reports.

[2] I note at the outset that six BP experts responded to my Round 1 Report, often making similar points on overlapping subject matters (e.g., Drs. Tunnell, Scott and Shea all discussed fish in one way or another). Throughout I have tried to ground my responses in whichever of the BP Round 2 Reports most directly addresses a given topic. However, to the extent that more than one BP expert rebutted my assessment of particular harm to a particular ecosystem or resource, this report serve as a response to all of them (e.g., my response to Dr. Tunnell's discussion of dolphins may serve to rebut points raised in Dr. Geraci's report as well). Therefore, any cross referencing to paragraph numbers do not serve to limit my rebuttal to any cited paragraph, rather I have included them for convenience.

Instead of acknowledging the seriousness of harm, they deny that any existed or simply explain away undeniable harm as insignificant.

2.2. The BP Round 2 Reports continue the strategy of providing misleading representations of harm by presenting results in the context of large regions not affected by oil contamination.

The strategy of geographic minimization on which the BP Round 1 Reports were based continues in the Round 2 Reports. The strategy trivializes the harm to fish and shellfish, birds, length of oil shoreline and extent of contamination in the Round 1 Reports. In the Round 2 Reports similar approaches result in BP's minimization of harm to deep-water corals, sea turtles, dolphins, and marine life exposed to surface oil slicks.

2.3. BP's Round 2 Reports continue to ignore or discredit any peer-reviewed literature that demonstrates actual or potential harm.

As pointed out in the Boesch and Rice Round 2 Report (p. 4-5), the opening BP expert reports relied primarily on *de novo* analyses of data with minimal reliance on the openly available, peer-reviewed literature. In contrast, my Round 1 Report relied preferably and nearly exclusively on the scientific literature. As a result, in rebuttal the BP experts had to (a) confront potential or real harm on components of ecosystems that their opening reports did not address (e.g., deep-water corals, sea turtles, dolphins, marsh erosion, and near-surface and bottom habitats offshore) and (b) demonstrate why my conclusions on potential or real harm that they did address in their opening reports were erroneous. To do so, the BP experts, continue to rely on their own *de novo* analyses and often seek to discredit, misinterpret, selectively quote from, or minimize the significance of peer-reviewed journal articles. The BP experts also continued to ignore important journal articles pertinent to harm caused by the Macondo well blowout on some ecosystem components (e.g., the Sargassum community, offshore plankton, lesions in bottom fish, and animals associated with salt marshes and embayments).

3. REPLY TO ROUND 2 REPORT OF DR. JOHN W. TUNNELL, JR.

3.1. "Studies relied upon by the United States demonstrate that the vast majority of deep-water corals were never affected by the spill."

Dr. Tunnell's opening Round 1 Report did not address the impacts on cold-water corals living on isolated hard carbonate substrates on the continental slope due to covering by oily residues, despite the fact that they have received prominent attention in the scientific literature as well as the popular press. In his Round 2 Report, Dr. Tunnell acknowledges that such effects occurred in the vicinity of the Macondo well blowout, but dismisses their significance by stating that the majority of deep-water coral communities in the Gulf were not affected (Tunnell Round 2 Report, paragraph 2). Merely placing the harm into the context of much larger areas that very likely were not exposed to Macondo well oil does not obviate the harm.

Cold-water coral colonies do not blanket the seafloor, but exist on small, isolated sites. The corals and associated communities are considered a rare biological resource of

unique biodiversity, with known occurrences along the continental slope of the northern Gulf numbering less than 100 (Figure 1). Dr. Tunnell observes that Fisher et al. visited 13 formerly known deep-water coral sites in October 2010 and did not detect visual indications of acute effects at any of these sites.[3] However, he does not reveal that some of these sites were as far west as 93.60° W, or 500 km from the Macondo well. Of the 10 sites closer to the Macondo well visited by Fisher et al. in 2011, they found distinctive signs of damage to colonies consistent with damage due to coverage by oily flocculent material at three sites, extending as far as 22 km from the well.[4] All three sites were between 1,370 and 1,850 meters in water depth, within the depth range of or just below the hydrocarbon-rich deepwater plume emanating from

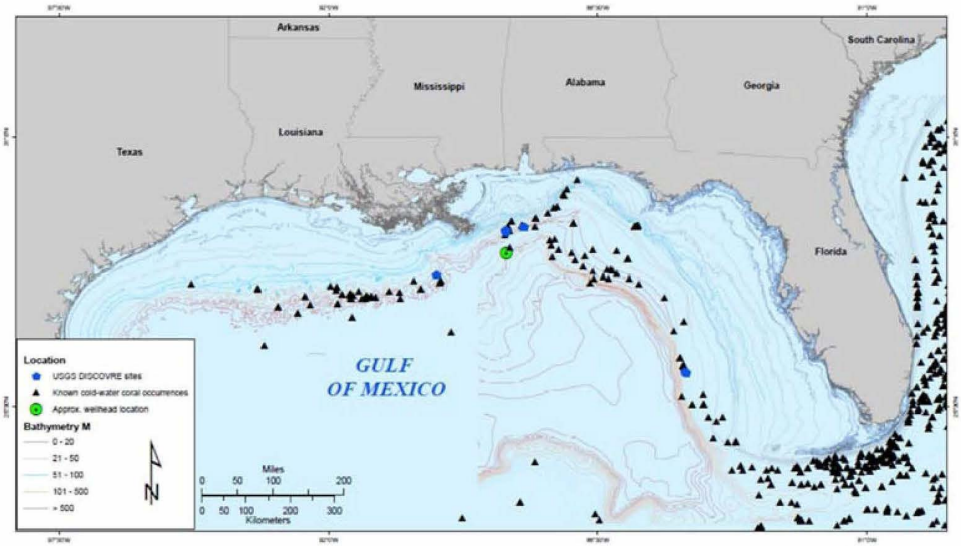

Figure 1. Location of cold-water coral occurrences known at the time of the Macondo well blowout http://fl.biology.usgs.gov/pdf/20100504Gulf_corals_v1.pdf. The figure presented in Appendix A in Dr. Tunnell's Round 2 Report is misleading in that it includes numerous records of coral occurrence in the warmer waters of the continental shelf.

the Macondo well blowout (Boesch Round 1 Report, p. 25-26). All of the unaffected colonies were at depths shallower than 1,090 meters and were therefore not likely reached by the deepwater plume.

As Fisher et al. clearly state: "The data presented here . . . indicate that impact from oil and/or dispersant from the DWH spill occurred at depths greater than 1,000-1,3000 as predicted by most models."[5] It is true that not all colonies at any given site were affected and that only parts of the colonies affected were killed, but the significance of the observed effects on cold-water corals must be considered from the perspective that

[3] Fisher CR, Hsing P-Y, Kaiser CL, Yoerger DR, Roberts HH, Shedd WW, Cordes EE, Shank TM, Berlet SP, Saunders MG, Larcom EA, Brooks JM (2014) Footprint of Deepwater Horizon blowout impact to deep-water coral communities. Proc Natl Acad Sci USA 111:11744-11749, p. 11744

[4] Fisher CR, Hsing P-Y, Kaiser CL, Yoerger DR, Roberts HH, Shedd WW, Cordes EE, Shank TM, Berlet SP, Saunders MG, Larcom EA, Brooks JM (2014) Footprint of Deepwater Horizon blowout impact to deep-water coral communities. Proc Natl Acad Sci USA 111:11744-11749, Table 1.

[5], Fisher CR, Hsing P-Y, Kaiser CL, Yoerger DR, Roberts HH, Shedd WW, Cordes EE, Shank TM, Berlet SP, Saunders MG, Larcom EA, Brooks JM (2014) Footprint of Deepwater Horizon blowout impact to deep-water coral communities. Proc Natl Acad Sci USA 111:11744-11749, p. 11748

colonies at some affected sites were determined to be 460 years old[6]—dating from around the time Hernando de Soto was exploring the Gulf Coast. For these reasons, the Department of the Interior and the oil and gas industry go to great pains to avoid impacting them in leasing and development requirements.

While not mentioning the peer-reviewed literature on cold-water coral effects in his opening Round 1 Report, Dr. Tunnell selectively considers this literature in his rebuttal. For example, he points out that recovery was observed where coral colonies suffered only low levels of coverage by an oily flocculent material just after the Macondo well was capped (paragraph 6), but he fails to mention that where coverage was more substantial, the coral colonies have not recovered, but have been replaced by hydroids growing on the remaining coral skeleton.[7] Furthermore, while he attempts to further trivialize the significance of coral impacts by resurrecting the suggestion that that the impacts could be caused by natural seeps, he fails to consider a publication that effectively demonstrated why this could not be so.[8] Finally, Dr. Tunnell's tangent about the impact of fishing operations on deep-water corals, while significant to the ecology and conservation of these communities, is completely irrelevant to the harm attributable to the Macondo well blowout.

3.2. "Data show very limited harm to sea turtles and near 100% recovery of those turtles that were oiled."

Dr. Tunnell's representations regarding the low proportion of stranded carcasses that were oiled (Tunnell Round 2 Report, paragraph 6), their causes of death (paragraph 7), the recovery rate of rehabilitated turtles (paragraph 8), and increased observation as the reason for increased strandings (paragraph 9) simply do not support his opinion that there was very limited harm to sea turtles as a result of the Macondo well blowout.

As Dr. Tunnell indicates (paragraph 8), the substantial majority of 456 live turtles that were collected with visible oiling survived after veterinary care and rehabilitation. Of the live turtles collected at sea, 85% were visibly oiled, but these rescue efforts were constrained and covered only a small portion of the overall footprint and duration of floating oil. The survival of carefully rehabilitated turtles says nothing about the survival of the substantially greater number of offshore turtles that encountered oil and were not rescued and rehabilitated. Indeed, the fact that several hundred oiled turtles were captured for rehabilitation strongly suggests that a much larger number of turtles were oiled given the very large spatial and temporal extent of surface oiling. Furthermore, while 14,000 sea turtle hatchlings taken from the Gulf Coast were

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[6] White HK, Hsing P-Y, Cho W, Shank TM, Cordes EE, Quattrini AM, Nelson RK, Camilli R, Demopoulos AWJ, German CR, Brooks JM, Roberts HH, Shedd W, Reddy CM, Fisher CR (2012) Reply to Boehm and Carragher: Multiple lines of evidence link deep-water coral damage to Deepwater Horizon oil spill. Proc Natl Acad Sci USA 109:E2648

[7] Fisher CR, Hsing P-Y, Kaiser CL, Yoerger DR, Roberts HH, Shedd WW, Cordes EE, Shank TM, Berlet SP, Saunders MG, Larcom EA, Brooks JM (2014) Footprint of Deepwater Horizon blowout impact to deep-water coral communities. Proc Natl Acad Sci USA 111:11744-11749, p. 11745

[8] White HK, Hsing P-Y, Cho W, Shank TM, Cordes EE, Quattrini AM, Nelson RK, Camilli R, Demopoulos AWJ, German CR, Brooks JM, Roberts HH, Shedd W, Reddy CM, Fisher CR (2012) Reply to Boehm and Carragher: Multiple lines of evidence link deep-water coral damage to Deepwater Horizon oil spill. Proc Natl Acad Sci USA 109:E2648

released to the Atlantic Ocean, this represents a net loss of those hatchlings from the Gulf of Mexico sea turtle stocks, which are genetically distinct.[9]

As for sea turtles collected dead, most were stranded onshore. Strandings are extremely negatively biased (i.e., they underestimate mortality) and, therefore, a poor indicator of total mortality or causes of death.[10] For a stranded carcass to be detected, it must persist (in the face of decomposition and scavenging) and remain buoyant for enough time to reach shore; be moved by wind and surface currents toward shore and actually come ashore; persist decomposition and scavenging while on the shore long enough to be detected; and be on a shore that is frequently patrolled or visited. The carcasses of sea turtles that were killed after coming into contact with floating Macondo oil far from shore, where oil as the thickest and most prevalent, had a relatively low probability of being stranded on the shore due to prevailing offshore winds, decomposition, scavenging, and sinking. Turtles that died as a result of drowning in shrimp trawls on the inner continental shelf would have a greater probability of stranding. Consequently, the fact that necropsies point to a possibility that a large number may have drowned in fishing gear is in no way evidence that the mortality of sea turtles due to Macondo oil was insignificant.

Along these lines, the relative absence of evidence of oil exposure in the strandings records is not, by itself, evidence of absence of such exposure and related harm. Dr. Tunnell (paragraph 6) attempts to refute my statement that sea turtles suffered significant mortalities by indicating that of the 618 sea turtles listed in the Consolidated Fish and Wildlife Collection Report as "collected dead," only 18 were "visibly oiled". Further, he purports (paragraph 8) that the United States has stated that most "collected dead" sea turtles were not killed by oil. He cites Sara McNulty's deposition that the "Status of oiling was not meant to indicate the cause of stranding or the cause of death of any of these animals." During that deposition, McNulty was asked[11] "Generally speaking, in these necropsy reports and the others discussed today does the exclusion of mention of oil mean that the turtles collected or marine mammals collected were not negatively impacted by the Deepwater Horizon spill or response?" She answered: "It does not." In other words, the absence of visible oil on relatively smooth organisms like sea turtles, which lack feathers or hairs onto which oil readily adheres, does not mean that oil did not contribute to their death.

Finally, Dr. Tunnell suggests (paragraph 9) that increased human presence during the spill response led to higher observations of sea turtle strandings compared to previous years. While increased search effort would probably increase the likelihood of discovery, Dr. Tunnell presents no quantitative analysis that this would account for the five-fold increase in sea turtle strandings above the historic rate (Boesch Round 1

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[9] Smablin BM and 19 others (2012) Expanded mitochondrial control region sequences increase resolution of stock structure among North Atlantic loggerhead turtle rookeries. Mar Ecol Prog Ser 149:145-160.

[10] Several studies have reported that fewer than 20% of sea turtles carcasses actually strand on beaches. Epperly SP, Braun J, Chester AJ, Cross FA, Merriner JV, Tester PA, Churchill JH (1996) Beach strandings as an indicator of at-sea mortality of sea turtles. Bull Mar Sci 59:289-297. Hart KM, Mooreside P, Crowder LB (2006) Interpreting the spatio-temporal patterns of sea turtle strandings: Going with the flow. Biol Conserv 129:283-290. Koch V, Peckham H, Mancini A, Eguchi T (2013) Estimating at-sea mortality of marine turtles from stranding frequencies and drifter experiments. PLOS One 8:e56776. My opinions regarding the biases of turtle stranding data also apply to assumptions about harm to birds and marine mammals based on stranding data (Sections 3.3 and 3.4, respectively).

[11] Dep. Of Sara McNulty at 278:14-22.

Report, p. 19). A careful, multivariate analysis would be necessary to ascertain the relative contributions of the variety of factors, including search effort, on the patterns of stranding over space and time.

3.3. "The United States alleges bird injury based upon a *New York Times* article and unpublished models which apparently even they have not seen; actual data indicate that there were no significant impacts to bird populations resulting from the spill."

Large numbers of birds were killed by oil from the Macondo well blowout, but Dr. Tunnell provides no alternative estimates of that mortality on which to evaluate the effects on bird populations. Contrary to Dr. Tunnell's assertion (Tunnell Round 2 Report, paragraph 12), I relied on the full peer-reviewed publication that presented the results of models that estimated the total mortalities of coastal birds and not a *New York Times* article or just the abstract of the article. This article had been accepted for publication in the journal *Marine Ecology Progress Series*, which unlike some other journals only makes abstracts and not the complete articles available prior to print publication. I contacted the lead author, who provided a copy of the full article that indicated that it was in press except for "final proofing of type-setting in journal format." A copy of that article[12] was provided to BP among the relied upon materials together with the Boesch Round 1 Report and was thus available for Dr. Tunnell's consideration prior to Round 2 Report.

My point in citing that article was to demonstrate that, based on past experience and accepted methods for modeling avian oil spill victims, the actual bird mortality was very likely much larger that the number of carcasses recovered. Dr. Tunnell's reference statistics related to the effects of the Macondo blowout on bird populations were the roughly 2,600 oiled bird carcasses collected (Tunnell Round 1 Report, paragraph 110) and the roughly 3,000 birds observed alive that had at least a trace of oil (paragraph 128). Dr. Tunnell's Round 2 Report does at least acknowledge that the actual bird mortality was greater than the number of beached birds discovered because of such factors as carcass detection rates (paragraph 13) and the persistence (paragraph 14) and sinking (paragraph 15) of carcasses. The model estimates to which I referred take these factors and others (for example, the prevalence of offshore winds that reduce the likelihood of dead birds beaching) into account.[13] I did not myself attempt to model bird mortality utilizing site-specific data as Dr. Tunnell suggested would have produced lower results "in line with the population data" [it is not clear to which data he refers]. I cited a peer-reviewed publication that attempted to model the effects of these factors. At the same time, Dr. Tunnell himself avoids any quantitative estimation of actual bird mortality attributable to the Macondo blowout.

Dr. Tunnell's assertion that there were no significant impacts to bird populations does not, in fact, derive from any computations based on the actual bird mortality associated with the Macondo well blowout, but from annual bird count surveys made at several

[12] 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 (US_PP_DBO006193).

[13] 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

places along the Gulf Coast in the following years (Tunnel Round 2 Report, paragraph 17). As was documented in the Boesch and Rice Round 2 Report (p. 10-11), Dr. Tunnell's analysis of these data is incapable of quantifying impacts within the geographic areas where they actually occurred because the survey sites were all on land and abundances were averaged over several sites, most of which experienced no or very low oiling. The repeating of his observation that 99.33% of birds observed were not visibly oiled, even if assumed to be accurate, says nothing about the fate of the several thousand birds that were observed with visible oil or the many thousands of birds that likely were oiled but not observed.

3.4. "Increased dolphin strandings began before the spill; data do not indicate a spill-related impact to dolphins."

In my opening report I wrote that: "Marine mammal stranding data indicate a prolonged unusual mortality event (UME) for bottlenose dolphins has been occurring from around the time of and subsequent to the blowout" (Boesch Round 1 Report, p. 39). Dr. Tunnell asserts that the UME began in February 2010 (Tunnel Round 2 Report, paragraphs 18-19) and that UMEs are not actually unusual (paragraph 20) or might not have even occurred during the incident (paragraph 23). The frequency of strandings was, in fact, unusual: it was more than four times the historical average and as much as eight times that average during some months during the blowout. Claiming that there were more observers or increased public awareness cannot explain away the much higher frequency without some quantitative assessment of the degree to which these factors would have affected stranding records.

While there were some increases in dolphin strandings a few months prior to the Macondo well blowout, even greater increases in strandings occurred during the months when Macondo oil spread into coastal waters and in those sections of the coast that were most affected. Furthermore, as with sea turtles and birds, the number of stranded carcasses must be but a fraction of the number of dolphins that died during an interval of time.[14]

Dr. Tunnell also opines that there are many likely causes for dolphin mortality unrelated to the oil spill and that medical records do not indicate that a single dolphin died because of it (Tunnell Round 2 Report, paragraphs 21-22). Indeed, I acknowledged that there may be multiple causes of bottlenose dolphin deaths, but as was pointed out in the Boesch Round 1 Report (p. 43) and the Boesch and Rice Round 2 Report (p. 14) in the real world animals must contend with multiple stressors that are often synergistic. For example, the additional stress due to exposure to oil could well make dolphins more susceptible to infectious brucellosis, the proximate cause of death of one-third of the dolphins tested in the UME. The difficulties in determining the cause of death through necropsies are discussed in Section 4.1.

Finally, Dr. Tunnell offers some criticisms of the study of health effects in Barataria Bay dolphin populations to which I referred (Boesch Round 1 Report, p. 39). I provide a response to these criticisms in Sections 4.2 and 4.3.

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[14] Heltier H, Baagøe HJ, Camphuysen K.C.J, Czeck R., Dabin W, Daniel P, Deaville R, Haelters J, Jauniaux T, Jensen LF, Jepsen, PD, Keijl GO, Siebert U, Van Canneyt O, Ridoux V (2013) The stranding anomaly as population indicator: The case of the harbor porpoise *Phocoena phocoena* in North West Europe. PLOS One 8(4):e62180

3.5. "The United States experts misconstrue the lessons from the *Exxon Valdez* and *Ixtoc* oil spills."

I made several factual statements in my Round 1 Report (p. 11) concerning the *Exxon Valdez* oil spill and the *Ixtoc* well blowout that relate to the amount of oil released and area of sea surface and shoreline oiled. Dr. Tunnell does not dispute these statements. The lessons he believes that I misconstrued apparently concern the completeness and speed of recovery (Tunnell paragraph 28). I did mention that certain components of the ecosystem in Prince William Sound recovered slowly from the Exxon Valdez oil spill because of lingering contamination and inherent limitations in population recovery. In discussion of the challenges of assessing actual harm soon after an oil spill, I did mention the crash of Prince William Sound herring populations as an example of surprises and enigmas that can occur after an oil spill (Boesch Round 1 Report, p 42). I stand by those statements and believe they are well supported by the peer-reviewed literature.[15]

I wrote nothing at all about recovery from the *Ixtoc* well blowout in my opening expert report. However, Dr. Tunnell was widely quoted in the media including newspapers, television, *National Geographic* and the scientific journal *Nature* regarding his observations of remnants of oil in water and on land at sites in the Bay of Campeche that he revisited thirty years later in 2010. He was quoted lamenting, "The research was stopped. That was the real crime of that spill."[16] These views seem inconsistent with his characterization in his Round 2 Report (paragraph 24) that the environment recovered quickly.

3.6. "The United States does not provide evidence of adverse effects to fish and shellfish populations."

Dr. Tunnell continues to refuse to consider any evidence of effects on fish and shellfish that are not evident in regional surveys and landing statistics. Without providing any reasoning, he dismisses the ecotoxicological research presented in the peer-reviewed literature that we extensively reviewed in the U.S. Round 1 and Round 2 Reports as having no relevance to fish and shellfish populations (Tunnell Round 2 Report, paragraph 31). To support his case, Dr. Tunnell misinterprets a recent publication by Fodrie et al.[17] that addresses the relationships between toxicological and population-level research related to the Macondo well blowout and takes out of context a quotation from the paper regarding "an absence of measurable negative impacts among populations" (paragraph 29).

The Fodrie et al. paper is actually a synthesis and consensus among field ecologists and toxicologists who have conducted research on effects of Macondo oil on estuarine fishes that explains the mismatch between effects observed at the individual organism level and the ability to detect population-level effects (Figure 2). The article by no means suggests that a population level effect is necessary to prove ecological injury,

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[15] Peterson CH, Rice SD, Short JW, Esler D, Bodkin JL, Ballachey BE, Irons DB (2003) Long-term ecosystem response to the Exxon Valdez oil spill. Science 302:2082-2086

[16] Schrope, M (2010) The lost legacy of the last great oil spill. Nature 466:304-305

[17] Fodrie FJ, Able KW, Galvez F, Heck, Jr. KL, Jensen OP, López-Duarte PC, Martin CW, Turner RE Whitehead A (2014) Integrating organismal and population responses of estuarine fishes in Macondo spill research. BioScience 64:778-788.

nor does it conclude that no such injury resulted from the Macondo well blowout. Rather, it indicates that rushing to conclusions on either side of the argument is not warranted.

Dr. Tunnell (Round 2 Report, paragraph 31) continues to rest on his previously stated opinion that there were no adverse effects on fish and shellfish populations based on his analysis of "real-world data" from abundance surveys and landings. In the Boesch and Rice Round 2 Report (p. 11-13), we demonstrated that his analyses are based on species populations that may have experienced little exposure, abundances averaged over far greater than the area impacted, and inappropriate statistical methods. Populations would have to decline by more than 50% across large parts of the northern Gulf of Mexico that extend far beyond the extent of Macondo oil

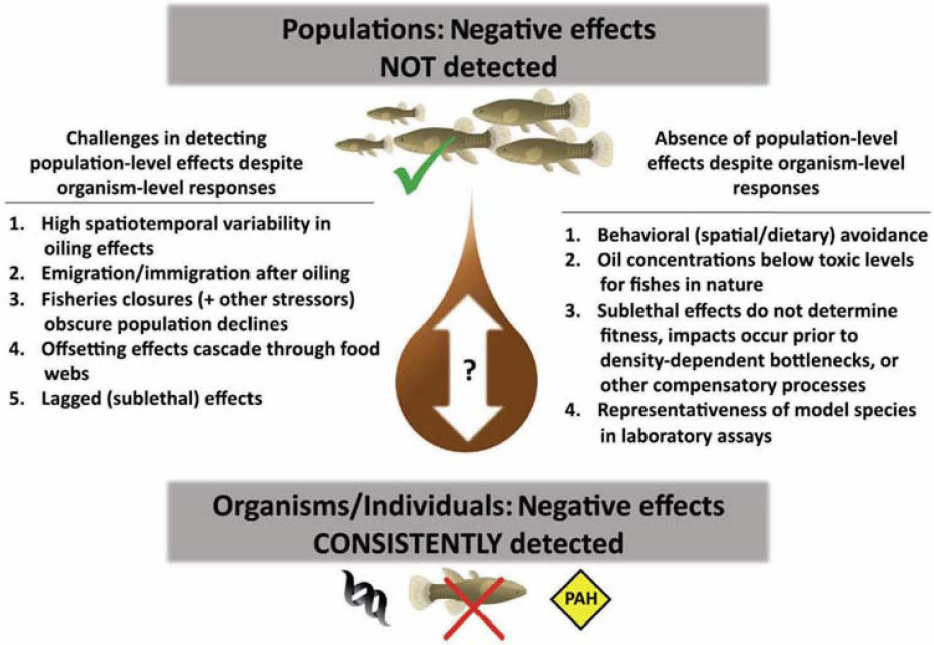

Figure 2. Schematic figure from Fodrie et al. (2014) that identifies the reasons why negative effects at the individual level might not be detected at the population level.

contamination in order to be detected by his methods. We found that his definitive conclusions related to harm are unsupported, highly speculative and premature.

[redacted]

[redacted]

4.2. "The combined results of follow-up hormone studies in 2013 clearly disprove the Schwacke et al. (2014) assertion that any of the dolphins from the 2011 study suffered from Addison's disease."

I am handicapped in responding to this statement because the follow-up studies have not been published and we only have Dr. Geraci's interpretation of their results (Geraci Round 2 Report, p. 6-7). However, while the hormone-indicators might have improved when they were sampled in 2013, this does not disprove that the Barataria Bay dolphins were suffering from hypoadrenocortism in 2011, as was concluded by Schwacke et al.

4.3. "Many of the 2011 Barataria Bay dolphins that were given a 'guarded or worse' prognosis or 'were not expected to survive' by Schwacke et al. (2014) (as carried forth in the government's report) were re-sighted in subsequent years, calling into question the basis for the original determinations."

Here again, Dr. Geraci presents his interpretation of information that is not publically available, much less published (Geraci Round 2 Report, p. 8). Nonetheless, according to Dr. Geraci's own analysis, by the end of 2012, about 40% of the dolphins sampled in August 2011 were no longer being re-sighted. Such a loss rate would be unusually high,[21] and would seem to support the hypothesis of poor survival for the Barataria Bay dolphin population.

[redacted]

[21] Speakman TD, Lane SM, Schwacke LH, Fair PA, Zolman ES (2010) Mark-recapture estimates of seasonal abundance and survivorship for bottlenose dolphins (Tursions truncates) near Charleston, South Carolina, USA. J Cetacean Res Manag 11:153-162.

[redacted]

5. REPLY TO ROUND 2 REPORT OF DR. LOREN SCOTT

As opposed to the declarative statements rebutting aspects of the expert reports by Dr. Charles Mason and Dr. Diane Austin, the part of Dr. Scott's Round 2 Report that addresses my opening expert report (Section 3) does not include a clearly stated statement of rebuttal. Beyond the observations about my qualifications and outlook, his main criticism is that I based my expert report on outdated studies, without looking at more-recent data that would undermine my conclusions.

As with many of the conclusions drawn in the BP expert reports, the continuing economic impacts cannot simplistically be reflected in the volume and value of fishery landings for the entire U.S. Gulf of Mexico.[24] There are other forces that drive the markets, including the effects of the fishery closures that allow stocks to rebound; the global economic market that affects the dockside price for Gulf seafood, particularly its most valuable fishery, shrimp; and the tarnishing of brand value of Gulf seafood. We are left with an unknown and shifting baseline: what would be the economic value of Gulf seafood had the Macondo well blowout not occurred and persisted? Whatever the interacting factors, it is clear that the economics values of Gulf seafood continue to impose some hardships in areas of southeastern Louisiana, Mississippi and Alabama.[25]

6. REPLY TO REBUTTAL REPORT OF ELLIOT TAYLOR, PH.D.

6.1. "Shoreline oiling estimates correctly omit Texas and, if anything, exceed the actual length of impacted shoreline."

Dr. Taylor makes a rather minor point that 36 miles of shoreline with trace oiling should not be included in my identification of 1,138 miles of oiled shoreline because it represents segments of the Texas coast for which measurements lacked the rigor, repeatability and comprehensiveness of SCAT surveys (Taylor Round 2 Report, paragraphs 4-6). I took this number from a paper co-authored by Dr. Taylor wherein it is noted: "shoreline oiling along the Texas coast was surveyed only once and using a slightly different approach, with a reported 58 km of trace oiling."[26] The Federal on

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[23] Schwacke LH, Smith CR, Townsend FI, Wells RS, Hart LB, Balmer BC, Collier TK, De Guise S, Fry MM, Guillette LJ, Lamb SV, Lane SM, Mcfee WE, Place NJ, Turnlin MC, Ylitalo GM, Zolman ES, Rowles TK (2014) Health of common bottlenose dolphins (*Tursiops truncatus*) in Barataria Bay, Louisiana, following the Deepwater Horizon oil spill. Environ Sci Technol 48:93-103

[24] Consistent with similar approaches employed by Drs. Tunnell, Taylor and Shea, Dr. Scott presents data on a very broad region extending far beyond the exposure to Macondo well oil, in this case the entirety of the Florida Gulf, Alabama, Mississippi and Louisiana, despite the fact that large areas of the Florida and Louisiana coast saw very little oil. This can conceal impacts that might have occurred in areas actually affected by the oil.

[25] *See, e.g.*, Sumaila UR, Cisneros-Montemayor AM., et al. (2012) Impact of the Deepwater Horizon well blowout on the economics of US Gulf fisheries. Can. J. Fish. Aquat. Sci. 69 (499-510) doi: 10.1139/F2011-171 at 501; Mason CF (2014) Round 2 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. 8-11.

[26] 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

Scene Coordinator (FOSC) and NOAA SCAT Coordinator, in fact, independently determined that these 36 miles received "trace" oiling from the Macondo well blowout based on a survey by the Texas General Land Office and USGS and chemical fingerprint analysis. In any case, the amount Dr. Taylor disputes is a mere 3% of the total and does not negate my point about the substantial extent of oiled shorelines—1,102 road miles would still get one from New Orleans to Washington, if not quite the 1,138 miles that would ensure reaching Baltimore.

Dr. Taylor takes exception with my observation that the length of shoreline indicated as oiled in the SCAT surveys is a conservative estimate of impact because it does not follow every "nook and cranny" (paragraph 7). First, he presents details on how segments of shoreline were characterized by SCAT, ultimately agreeing with what I wrote: that 1,102 miles of shoreline in Florida, Alabama, Mississippi and Louisiana received some level of oiling (paragraph 8). However, he misrepresents that I implied that this length of shoreline was contiguously oiled—I did not. Secondly, he goes into further details on how high-resolution imagery was used (paragraph 9), details that are irrelevant to my assertion that every "nook and cranny" was not necessarily accounted for. In her deposition, Dr. Jaqui Michel, (lead author of the paper on which Dr. Taylor is a co-author), indicates that in Louisiana in particular, SCAT surveys underestimated the complexity of the true shoreline and did not always observe oil that had been buried or covered by water at high water levels, particularly during early surveys in the summer of 2010 before SCAT surveys were restricted to periods of water levels below 0.5 ft.[27] SCAT teams initially focused on bulk or actionable oil, thus underestimating shorelines with moderate to light oiling. Consequently, the 2010 Rapid Assessment (RA) surveys conducted by the NRDA teams that included representatives of BP and the trustee agencies, documented 88.6 miles of oiled shoreline in Louisiana that were not so designated by SCAT surveys. Thirdly, Dr. Taylor's observation that SCAT teams surveyed from the backshore to the lower intertidal areas (paragraph 10) is irrelevant to my assertion that SCAT estimates of length of shoreline oiled are conservative.

Dr. Taylor (paragraph 11) misconstrues the inclusion of Figure 3 in my report as a demonstration of the extent of shoreline oiling. I made no such claim; in fact, the figure is used to illustrate the observation that "surface oil slicks extended over a vast area during the summer of 2010"[28]—hardly a controversial statement. Rather, I used the paper based on SCAT records and coauthored by Dr. Taylor to demonstrate the extent of shoreline oiling. Dr. Taylor attempts to discredit the Synthetic Aperture Radar satellite imagery used to construct the image of cumulative oiling days included in Figure 3. He raises red herrings about various environmental variables, natural occurring substances (including kelp beds and herring spawn that do not occur in the Gulf of Mexico), and substances introduced to the environment by human activity that can lead to "false positive" identification of sea-surface oiling when relying on satellite imagery. If this were a significant problem would not there be false positives throughout the Gulf and after floating oil was no longer found? My Figure 3

[27] Dep. Jaqueline Michel at 29:3-15.

[28] 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. 12-13. Note the callout for Figure 3 is in a section headed by "Surface oil slicks extend over a vast area during the summer of 2010" and the figure caption reads "Duration for which floating oil was observed during 2010."

convincingly represents the actual footprint of oiling of surface waters at least some time during 2010 and supports my conclusions regarding the actual and potential harm in surface waters of the Gulf of Mexico.[29] Beyond that, this floating oil footprint demonstrates the pathways along which the oil emanating from the Macondo well blowout reached the oiled shorelines along an expansive length of the Gulf Coast.

In summary, even if Dr. Taylor's assertions about the overestimation of shoreline impact were correct—and I have demonstrated that they are not—they would only marginally affect the extent of shoreline impacts, and thus the seriousness of actual or potential harm.

6.2. "Unified Command undertook extensive efforts to limit the impact from shoreline cleanup activities."

It was not an objective of my opening expert report to evaluate the effectiveness of the Unified Command's clean-up activities (Taylor Round 2 Report, paragraph 12). Nor did I opine on the Shoreline Treatment Recommendation (STR) or Net Environmental Benefit Assessment processes or the measures to minimize the impact of cleanup activities (paragraphs 13-14). I offered no judgment as to whether the efforts to minimize the impact of the Macondo blowout on the Gulf shoreline were successful and efficacious (paragraph 16). Thus, Dr. Taylor's rebuttal is misdirected and has no bearing on my opinions regarding the actual or potential harm. Rather, what I concluded was that, despite these efforts, there was still harm to coastal ecosystems. In at least some cases, this harm was likely reduced by cleanup efforts, but such efforts had their own associated impacts.

Any shoreline cleanup technique has some negative impact, including removal of physical substrate or organic matter, disturbance of nearby wildlife, damage to vegetation, and damage to archeological resources. Accordingly, the potential benefit of any cleanup action must be weighed against these negative impacts. Furthermore, substantial quantities of oil were left untreated (particularly in sensitive marshlands), not because the remaining oil did not present a threat to the environment, but because of the severe damage that would have been caused by removing the oil. It is also not accurate to say that BP did everything possible to respond to the most heavily oiled marshes: NOAA strongly recommended that the most heavily oiled parts of the north Barataria Bay marshes be rapidly replanted. BP chose not to do this because it regarded this a "restoration" activity and not a response action.[30] Yet, replanting could have substantially reduced further erosion and enhanced recovery. Nonetheless, the fact remains that neither the impacts of oiling nor the cleanup efforts would have occurred if the responsible parties had controlled the Macondo well, prevented the blowout or more quickly contained the blowout after it occurred.

6.3. "Marsh erosion did not occur in lightly or moderately oiled sites, and was limited in extent and duration in certainly heavily oiled areas."

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[29] 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. 18-23.

[30] Email from William Wallace to Robert Harrison et al., subject "RE: STR S3-045.r.1 (North Barataria Bay Marshes) for Pre-review" (Apr. 8, 2008, 2:38 PM).

In my expert report I wrote: "Where oiling was heavy the harm is long-term if not permanent. While marsh grass vegetation recovered within 18 months under low to moderate oiling, where heavy oiling resulted in complete mortality the denuded soils eroded away causing an episodic shoreline retreat" (Boesch Round 1 Report, p. 33). In his Round 1 Report, Dr. Taylor made no mention of the permanent marsh erosion that occurred as a result of heavy oiling by Macondo well oil in the 13 paragraphs he devotes to oiling of marshes and mangroves (Taylor Round 1 Report, p. 42-51). Dr. Rice and I pointed out this serious omission in our Round 2 response (Boesch and Rice Round 2 Report, p. 19). Now, in his rebuttal Dr. Taylor does not refute my statement regarding the effects of heavy oiling and I did not address whether erosion occurred in lightly or moderately oiled sites. In fact, through his citations of peer-reviewed reports on the subject and his own analysis of NRDA data (Taylor Round 2 Report, paragraph 21), he provides evidence for exactly what I wrote.

Erosion and permanent loss of marsh would seem to fit any reasonable definition of actual, serious harm. The remaining questions, then, are how extensive was this damage and whether it made marshes more vulnerable to subsequent marsh loss. While Dr. Taylor offers his opinion that erosion was limited in extent and duration "based on my review" of NRDA data (Taylor Round 1 Report, paragraph 22), he presents no data, analytical methods or quantitative results to support his opinion, much less subjects them to the scrutiny of peer review. Moreover, he writes: "the data collection and analysis from the three studies I evaluated is ongoing, and additional analyses are necessary to more precisely define and quantify any potential erosion that can be attributed to the spill, even at the most heavily oiled sites, and specifically to adequately account for the significant background, or natural rates or erosion that are a confounding factor in all of the studies." This is tacit recognition that his opinions about the extent and duration of marsh erosion are, at the least, premature and is another instance where it is not appropriate to get ahead of the NRDA process.

Regarding the important issue of whether marsh plant mortality and soil disintegration resulting from heavy oiling made marshes more vulnerable to subsequent marsh loss, Dr. Taylor overstates the conflict between two published studies that wetland erosion due to oiling (Taylor Round 2 Report, paragraph 30). The earlier of the two studies found that erosion rates leveled off to background rates after 1.5 years,[31] while the latter study found higher than background rates persisted more than two years and explained that the difference may be related to the latter study's larger sample size and wider range in the degree of oiling.[32] The latter authors wrote: "The full extent of the DWH oil's impact may not be evident for many years; the weakening of the soil and possible decrease in organic matter accumulation could lead to submergence of the marsh edge as relative sea level increases faster than the marsh can vertically accrete soil." Finally, although Dr. Taylor notes that both of these studies concerned only *Spartina alterniflora* marsh type (Taylor Round 2 Report, paragraph 20), their results are very relevant because it is by far the dominant vegetation type in exposed Gulf Coast marshes.

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[31] 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

[32] 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

7. REPLY TO ROUND 2 REPORT OF FRANK PASKEWICH, CAPT., USGC (RET.)

7.1. "The United States' experts offer certain opinions about the Deepwater Horizon response that are unfounded or incomplete."

Capt. Paskewich claims that some statements that I made about the potential effects of the response operations are unfounded (Paskewich Round 2 Report, p. 17). His rebuttal defends the response decisions, but does not in any way refute the conclusions in my expert report:

(a) Regarding the use of dispersants (Paskewich Round 2 Report, p. 17), while I did not specifically indicate that the dispersant applications were approved and monitored by the FOSC or that a group of 50 scientists gathered to consider dispersant use, this is immaterial to my conclusions that applications of chemical dispersants increased the incorporation of Macondo well oil into Gulf of Mexico waters. This is not disputed, as that is why dispersants are applied in the first place.

Figure 3. Heavily trafficked area around sand sifting machines and piles of sand being dried prior to sifting at Grand Terre, LA, 30 October 2010 (top). Shell material retained on sifting screen at West Dauphin Island, AL, 13 January 2011 (bottom).

(b) Regarding shoreline cleanup operations, I did not criticize the STRs or BMPs (Paskewich Round 2 Report, p. 18), but noted that some practices, even if prudent, have negative impacts as well as benefits (Boesch Round 1 Report, p. 31). I specifically mentioned vehicle traffic and the scraping, grading and deep cleaning of shoreline sediments (Figure 3) that altered the sand-shell habitat matrix that affects the habitats and sediment dynamics of beaches.

(c) Regarding barrier sand berms (Paskewich Round 2 Report, p. 18), I offered no judgment of their efficacy, but opined that they had both positive and potentially harmful consequences (Boesch Round 1 Report, p. 31-32).

(d) Regarding the harm to oyster stocks due to Mississippi River diversions (Boesch Round 1 Report, p. 36-37), Capt. Paskewich does not refute my conclusion, he just points out that these were not "response actions" taken by the Unified Command (Paskewich Phase 2 Report, p. 18). I included harm to oyster from Mississippi River diversions in my analysis because those diversions were efforts to mitigate the effects of approaching oil slicks, and the resulting harm would not have occurred absent the blowout.

8. REPLY TO ROUND 2 REPORT OF DR. DAMIEN SHEA

Dr. Shea addresses several issues raised in the separate Round 1 Reports by Stanley Rice and by me. As Dr. Rice's report dealt in greater depth in toxicology I will leave those issues that relate to this subject matter for him to respond. The following responses deal only with those other criticisms specifically directed at my opening expert report.

8.1. "The United States' environmental experts rely upon flawed toxicology methods to speculate about potential harm."

In criticizing Dr. Rice's "near-exclusive reliance on peer-reviewed literature," Dr. Shea writes: "As acknowledged by Dr. Boesch, the peer review process often is not able or designed to verify results and conclusions given the incompleteness of the available information" (Shea Round 2 Report, p. 6). I wrote nothing even remotely resembling this in my expert report. Rather, I stressed that I relied primarily on peer-reviewed journal articles because they: (a) include descriptions of methods, present detailed results from analyses, and discuss findings in the context of the broader body of scientific knowledge; (b) were subjected to review by scientific peers and to requirements by editors designed to insure quality and restrict the publication of unsubstantiated results; and (c) are readily accessible to the scientific community, which evaluates, incorporates and challenges their results and conclusions (Boesch Round 1 Report, p. 6). As detailed in our rebuttal of Dr. Shea's opening expert report (Boesch and Rice Round 2 Report p. 20-27), his analysis of environmental contaminant concentration data and toxicity tests has not been peer-reviewed and is seriously deficient in all three of these attributes of peer-reviewed journal articles.

8.2. "The environmental impact from surface oil was far less than the United States claims."

Dr. Shea criticizes my use of the SkyTruth estimate of the area of sea surface in the Gulf of Mexico over which floating oil from the Macondo well blowout floated at one time or another during 2010 (Shea Round 2 Report, p. 19-20). I referred to an area of 68,000 square miles (Boesch Round 1 Report, p. 12) and Dr. Shea correctly points out that the NOAA National Environmental Satellite, Data and Information Services (NESDIS) total cumulative area of daily composite anomalies was only 46,000 square miles. In fact, this smaller cumulative footprint based on the NESDIS measurements is exactly what I depicted in Figure 3 of my opening expert report. The NESDIS cumulative total is conservative because there were days on which the extent of surface oil could not be assessed because of could cover. In that sense, the NESDIS estimate should be considered a floor while the SkyTruth estimate might be a ceiling for the actual extent. To place the estimates in perspective, I indicated that the SkyTruth estimated cumulative area was greater than 50% of the land area of Louisiana. The NESDIS cumulative area estimate is still greater than the land area of Louisiana. Dr. Shea then points out that on most days surface oil extended over fewer than 3,861 square miles and deceptively depicts this area as a filled circle in the middle of the entire Gulf of Mexico far removed from the location of the Macondo well and from land in an apparent attempt to trivialize the extent of surface oil coverage. In reality, this 3,861 square mile daily footprint is greater than the land area of Orleans, St. Tammany,

Jefferson, St. Bernard, Plaquemines, St. Charles and Lafourche parishes, combined. From any reasonable perspective, the scale of harm resulting from surface oil covering such a large area on a daily basis for more than two months cannot be accepted as insignificant.

Nonetheless, Dr. Shea then criticizes the NESDIS estimates derived from satellite imagery by indicating they might be inflated by anomalies such as seaweed, oil from natural seeps, and oil leaks from passing vessels, wind sheen and gelatinous biofilm (Shea Round 2 Report, p. 23). However, if this were such a big factor, why would the oil slick footprint spread from the Macondo well[33] and not be anomalously indicated elsewhere in the Gulf? Dr. Shea also suggests that aerial overflight data from spill response provides detail missing from satellite anomaly maps (Shea Round 2 Report, p. 22). This may be true on the fine scale, but the surface oil was so widespread that aerial overflights could not capture the entire extent of oil coverage on a given day or with desired frequency, thus satellite provide more effective synoptic coverage. On large scales, the satellite and overflight estimations of the occurrence of oil were in significant agreement.[34] For this reason, synthetic aperture radar (SAR) measurements made from satellites are commonly used to define the area of surface oiling for oil spill response, but have not generally been used to distinguish oil slick thickness. In any case, I offered no characterization of slick thickness in my report.

8.3. "Drs. Rice and Boesch incorrectly imply that dispersants caused a significant increase in toxic exposure."

It is well accepted that dispersants enhance the dissolution of petroleum compounds into seawater from the liquid oil phase floating on the sea surface or ascending through the water column: that is their purpose. In fact, Dr. Shea writes: "Drs. Rice and Boesch are correct that dispersants increase the rate at which oil dissolves" (Shea Round 2 Report, p. 23). It just stands to reason then, that this increases the exposure of aquatic organisms to toxic compounds in the oil.

In my Round 1 Report I stated that: "Experimental results have repeatedly shown that mixtures of oil and dispersants in seawater are more toxic that of those with oil alone or dispersants alone. The toxic effect results primarily from dispersants increasing the concentrations of toxic oil compounds in solution, rather than increasing the inherent toxicity of the constituent compounds of dispersants themselves" (Boesch Round 1 Report, p. 21). This statement is consistent with statements in the deposition of Dr. Mace Barron and with the "the scientific community's understanding of the toxicity of dispersants or the toxicity of oil-dispersant mixtures" to which Dr. Shea refers in his point 9 (Shea Round 2 Report, p. 26).

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[33] Boesch DF (2014) Round 1 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, Figure 3

[34] Shea D (2014) Round 2 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, Figure B.1, Figure B.2; citing NOAA overflight survey for June 25, 2010 at 08:35-10:50 hours CDT layered on top of NESDIS composite satellite anomaly map for June 25, 2010; NOAA overflight survey for June 25, 2010 at 14:10-16:35 hours CDT layered on top of NESDIS composite satellite anomaly map for June 25, 2010.

Dr. Shea's rebuttal does not invalidate what I wrote. Rather, the points he is really attempting to make under this headline are:

(a) once in solution or in suspension as droplets or colloidal micelles, water flow and turbulence will "disperse" or reduce their concentrations over time (a basic fact), as will biodegradation;

(b) application of chemical dispersant effectively prevented much of the oil from reaching the most biologically important and sensitive regions of the Gulf;

(c) dispersants rarely reached toxic concentrations in the water column;

(d) spill responses prevented the applications of dispersants near the shoreline;

(e) monitoring showed that dispersant application did not result in extensive, harmful hypoxia; and

(f) dispersant application was preauthorized or authorized by the Regional Response Teams and advised by scientists and spill response experts.

None of these points are inconsistent with or neglected by my Round 1 Report, with one exception. While application of dispersants undoubtedly kept some oil from reaching sensitive coastal area, neither the government nor BP has yet quantified by how much or the degree to which harm to coastal ecosystems and resources was reduced, so any appraisal that dispersant applications were "effective" in keeping "much" of the oil from sensitive areas is unsubstantiated and premature. What Drs. Shea and Taylor do not directly address in either their Round 1 or Round 2 Reports is that the decision to apply dispersants was not a choice between serious potential harm and no potential harm: it was what everyone hoped would be the lesser of evils.

Contrary to Dr. Shea's position in his Round 2 Report, the applications of dispersants did increase the exposure of aquatic organisms to toxic components of oil and, as discussed in my report, likely increased the amount of oil deposited on cold-water corals and sedimentary environments (Boesch Round 1 Report, p. 24-25). I am not criticizing these decisions, merely pointing out that they were not without potentially harmful consequences.

8.4. "Dr. Boesch's discussion of a 'dirty blizzard' is theoretical; actual data demonstrates limited impact on the sea floor."

Dr. Shea's assertion (Shea Round 2 Report, p. 26) that the only citation I provided to support my description of the formation and deposition of oily marine snow was a news article summarizing unpublished findings is incorrect. My reference to the news article was merely to provide reference to the popularization of this phenomenon as a "dirty blizzard." In fact, I cited a peer-reviewed article by Passow et al. published in 2012 that provided observational and experimental evidence of the formation of marine snow as a result of the Macondo well blowout (Boesch Round 1 Report, p. 17). I also cited a peer-reviewed article by Mason et al. that discusses the responses of the sediment microbial community to the deposition of this these oily aggregates, as well as several articles on the deposition of oily residues on cold-water corals (Boesch Round 1 Report, p. 25-26). The latter included a paper that responded to a critique by

scientists associated with firms conducting studies for the oil industry by providing chemical evidence for the deposition of the settling oily residues.[35]

The entrainment and deposition of Macondo oil in the water column by marine snow is not theoretical, but has been demonstrated by observations, environmental measurements and experiments. The explorer William Beebe first used the term "marine snow" to describe the drifting aggregates he observed from his bathysphere in the 1930s. Since then there have been many thousands of scientific articles published on this phenomenon and its importance in ocean ecosystems; many of these relate to their role in deposition of organic and inorganic contaminants. There is strong visual, chemical and sedimentological evidence that this was an important mechanism for the deposition of Macondo oil on the sea floor, as illustrated in the photographs shown in Figure 4.[36] The phenomenon, termed Marine Oil Snow Sedimentation and Flocculent Accumulation (MOSSFA), is an area of active research within the scientific community investigating the consequences Macondo well blowout and was the subject of a workshop in St. Petersburg, Florida, in October 2013[37] and a town hall meeting at the January 2014 Gulf of Mexico Oil Spill and Ecosystem Science Conference in Mobile.[38] A report on the 2014 workshop indicated: "The consensus of the group was that accumulation of oil at the seafloor may provide a pathway for protracted exposure, uptake, and continued metabolism of toxic and carcinogenic petroleum hydrocarbons by ecologically, economically, and recreationally important benthic fish."

Figure 4. Sediment cores taken from continental slope sites in May and September 2010 showing the deposition of oily flocculent material at the sediment-water interface.

Dr. Shea (Shea Round 2 Report, p. 26) takes a quotation attributed to me that appeared in a 2013 news article out of context of what preceded it in the article: "Hollander said this week that, taken together, the dirty bathtub and dirty blizzard may have sent up to

[35] White HK, Hsing P-Y, Cho W, Shank TM, Cordes EE, Quattrini AM, Nelson RK, Camilli R, Demopoulos AWJ, German CR, Brooks JM, Roberts HH, Shedd W, Reddy CM, Fisher CR (2012) Reply to Boehm and Carragher: Multiple lines of evidence link deep-water coral damage to Deepwater Horizon oil spill. Proc Natl Acad Sci USA 109:E2648

[36] Joye SB, Teske AP, Kostka JE (2014) Microbial dynamics following the Macondo oil well blowout across Gulf of Mexico environments. BioScience 64:766-777

[37] Center for Spills in the Environment (2013) Marine Oil Snow Sedimentation and Flocculent Accumulation (MOSSFA) Workshop. Center for Spills in the Environment. University of New Hampshire, 37 p. http://crrc.unh.edu/sites/crrc.unh.edu/files/marineoilsnowsedimentationflocculentaccumulationworkshopreport2014.01.17.pdf

[38] Kinner NE, Belden L, Kinner P (2014) Unexpected sink for Deepwater Horizon oil may influence future spill response. Eos 95:176.

30% of the spilled oil to the bottom of the Gulf of Mexico." "Donald Boesch . . . is not convinced by this figure. 'I find it hard to believe' he says, noting that the concentrations measured in most concentrations have been small." The article is unambiguous that what I found hard to believe was the 30% figure because if this much oil had been deposited on the sea floor it would have resulted in even higher levels of sediment contamination that those being reported at that time. I fully accepted then and am even more convinced now that deposition of oily marine snow brought a significant amount of oil to the sea floor. Such deposition was not "a big slick of oil sinking to the bottom" (Shea Round 2 Report, p. 27), but was a more diffuse blanketing with organic and inorganic material that includes petroleum hydrocarbons. This may be why NOAA or the Coast Guard, as Dr. Shea suggests, did not consider the oily deposits as "actionable" for clean-up.

Dr. Shea continues to ignore or reject the peer-reviewed literature. Instead he maintains the position that oil contained in marine snow would have been degraded by the time it reached the sea floor and that the deposition of oily marine snow could not be important because he judged 98% of the sediment samples collected from throughout the northern Gulf of Mexico safe for sediment dwelling organisms (Shea Round 2 Report, p. 27). These positions disregard the significance of the peer-reviewed study by Montagna et al. that documents a 148 square kilometer area of moderate to severe impacts on sediment dwelling organisms[39] and misrepresents the chemical evidence of oil contamination included in that study and others.[40] Dr. Shea's assertion that "There is no conclusive evidence showing that oil from the spill resulted in these impacts to deepwater coral communities" (Shea Round 2 Report, p. 28) is also counter to the significant peer-reviewed scientific literature that I reviewed in Section 3.1 of this report. Dr. Tunnell, on the other hand, accepts that these impacts occurred, but just concludes that they did not affect "the vast majority of deep-water corals" (Tunnell Round 2 Report, paragraphs 2-4).

9. CONCLUSIONS

9.1. The BP Round 2 Reports do not raise valid criticisms or new evidence that would require me to alter the conclusions of my opening Round 1 Report.

The only detail in my report that I would like to qualify is to note that the total cumulative extent of floating oil officially estimated by NOAA was 46,000 square miles, less than the 68,000 I mentioned based on another source. However the NOAA estimate should be considered as conservative, this a floor, with the actual extent very likely somewhere between these two estimates. The existing evidence still shows that substantial actual harm was realized among planktonic organisms and floating seaweed communities; deep seabed biota, including cold-water coral communities; moderately to heavily oiled coastal saltmarsh and mangrove habitats and birds, sea turtles and bottlenose dolphins exposed to oil slicks. There was potential harm to at least bottom fishes living where hydrocarbons contaminated sediments; open-ocean fishes with larvae that develop near the sea surface; biota inhabiting the seabed on the

[39] 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
[40] 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 64:796-804

continental shelf in the vicinity of substantial floating oil; and oyster stocks in areas affected by oil and related response activities.

9.2. The BP Round 2 Reports also do not resolve the criticisms raised in the U.S. Round 2 Report pertaining to the BP Round 1 Reports.

The BP Reports taken collectively, draw conclusions concerning harm to Gulf ecosystems and resources that are not based on definitive analyses of actual harm and are, at the least, premature. These reports fail to consider all evidence of impacts and unreasonably reject such evidence in the peer-reviewed literature when it is confronted. They still neglect to consider some ecosystem components (e.g., the Sargassum community, offshore plankton, lesions in bottom fish, and animals associated with salt marshes and embayments) at all. Both their sweeping conclusions purporting to find *de minimis* and ephemeral harm and the rebuttals against scientific evidence to the contrary are based on flawed analyses of selected data. The extent of harm is concealed or diminished by presenting results in the context of large regions not affected by oil contamination. Consequently, the BP expert reports and rebuttals in no way demonstrate that actual or potential harm was not serious.

9.3. While the BP Round 2 Reports now address some of the important ecosystems and living resources omitted in the BP Round 1 Reports, weaknesses in their arguments only reinforce my original conclusions.

The BP Round 2 Reports address several effects that were not addressed in the BP opening expert reports, including those on deep-water corals, sea turtles, dolphins, marsh erosion, and near-surface and bottom habitats offshore. In each case those reports aim at questioning, minimizing or obfuscating the effects. Based on my review and discussion of those reports, I believe that my conclusions have not only been sustained, but in some cases reinforced.

9.4. The evidence presently available in the scientific commons supports a conclusion that the actual and potential harm was serious; however, the full quantification of that harm remains to be determined.

The ongoing Natural Resources Damage Assessment is the process by which natural resource damages are being quantified. Furthermore, BP committed $500 million for research related to the Macondo blowout being managed by the Gulf of Mexico Research Initiative. This research is also contributing to understanding and quantification of the harm to Gulf of Mexico ecosystems.

Sources Considered
(In addition to the documents cited in my Round 1 and Round 2 and Round 3 reports and my Round 1 and Round 2 lists of documents considered)

Bates, Exhibit, TREX, or Other Description
BP-HZN-2179MDL02042412-BP-HZN-2179MDL02042420
BP-HZN-2179MDL09230498-BP-HZN-2179MDL09230503
BP-HZN-2179MDL09244414-BP-HZN-2179MDL09244423
BP-HZN-2179MDL09293985-BP-HZN-2179MDL09294008
BP-HZN-2179MDL09294289-BP-HZN-2179MDL09294294
BP-HZN-2179MDL09294438-BP-HZN-2179MDL09294450
BP-HZN-2179MDL09294656-BP-HZN-2179MDL09294724
BP-HZN-2179MDL09294730-BP-HZN-2179MDL09294940
BP-HZN-2179MDL09294942-BP-HZN-2179MDL09294966
BP-HZN-2179MDL09295041-BP-HZN-2179MDL09295082
BP-HZN-2179MDL09295116-BP-HZN-2179MDL09295129
BP-HZN-2179MDL09296068-BP-HZN-2179MDL09296076
BP-HZN-2179MDL09296142-BP-HZN-2179MDL09296147
BP-HZN-2179MDL09296313-BP-HZN-2179MDL09296316
BP-HZN-2179MDL09296330-BP-HZN-2179MDL09296344
BP-HZN-2179MDL09296360-BP-HZN-2179MDL09296378
BP-HZN-2179MDL09296524-BP-HZN-2179MDL09296535
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BP-HZN-2179MDL09311023-BP-HZN-2179MDL09311024
BP-HZN-2179MDL09311049-BP-HZN-2179MDL09311049
BP-HZN-2179MDL09311453-BP-HZN-2179MDL09311474
Deposition Exhibit 11766
Deposition Exhibit 11771
Deposition Exhibit 11772
Deposition Exhibit 12078
Deposition Exhibit 12097
Deposition Exhibit 12382
Deposition Exhibit 13004
Deposition of McNulty, Sara (July 1, 2014)
Deposition of Michel, Jacqueline (Aug. 1, 2014)
EPF211-000590-EPF211-000592
Expert Report of Damian Shea (Corrected)
Expert Report of Donald F. Boesch, Actual and Potential Harm from the Macondo Well Blowout
Expert Report of Dr. Damian Shea
Expert Report of Dr. John W. Tunnell, Jr.
Expert Report of Dr. Loren Scott
Expert Report of Elliott Taylor
Expert Report of Frank M. Paskewich

Sources Considered

(In addition to the documents cited in my Round 1 and Round 2 and Round 3 reports and my Round 1 and Round 2 lists of documents considered)

Bates, Exhibit, TREX, or Other Description
Expert Report of Joseph R. Geraci
Expert Report of Stanley D. Rice, Toxicological Impact of the MC252 Blowout, Oil Spill, and Response
Expert Report of Wes Tunnell (Corrected)
Expert Response Report of Charles F. Mason
N6J021-003010-N6J021-003024
OSE232-014157-OSE232-014157
PPDEPODOC000348-PPDEPODOC000353
PPDEPODOC013913-PPDEPODOC013918
Rebuttal Expert Report of Frank M. Paskewich
Rebuttal Report of Elliott Taylor
TREX-020327
US_PP_DBO002715-US_PP_DBO002723
US_PP_DBO003060-US_PP_DBO003065
US_PP_DBO004603-US_PP_DBO004612
US_PP_DBO004684-US_PP_DBO004685
US_PP_DBO005095-US_PP_DBO005103
US_PP_DBO006138-US_PP_DBO006149
US_PP_DBO006193-US_PP_DBO006258
US_PP_DBO007388-US_PP_DBO007398
US_PP_DBO007422-US_PP_DBO007433
US_PP_DBO007960-US_PP_DBO007968
US_PP_DBO007969-US_PP_DBO007976
US_PP_DBO007977-US_PP_DBO007986
US_PP_DBO007987-US_PP_DBO007999
US_PP_DBO008000-US_PP_DBO008013
US_PP_DBO008014-US_PP_DBO008029
US_PP_DBO008030-US_PP_DBO008030
US_PP_DBO008031-US_PP_DBO008045
US_PP_DBO008047-US_PP_DBO008055
US_PP_DBO008080-US_PP_DBO008082
US_PP_DBO008083-US_PP_DBO008092
US_PP_DBO008093-US_PP_DBO008103
US_PP_DBO008104-US_PP_DBO008108
US_PP_DBO008121-US_PP_DBO008123
US_PP_DBO008124-US_PP_DBO008137
US_PP_DBO008138-US_PP_DBO008142
US_PP_DBO008143-US_PP_DBO008150
US_PP_DBO008151-US_PP_DBO008187
US_PP_DBO008188-US_PP_DBO008199
US_PP_DBO008200-US_PP_DBO008200
US_PP_DBO008201-US_PP_DBO008202

Sources Considered

(In addition to the documents cited in my Round 1 and Round 2 and Round 3 reports and my Round 1 and Round 2 lists of documents considered)

Bates, Exhibit, TREX, or Other Description
US_PP_DBO008203-US_PP_DBO008212
US_PP_MAS001580-US_PP_MAS001591
US_PP_MVH000023-US_PP_MVH000030
US_PP_NOAA143877-US_PP_NOAA143931
US_PP_NOAA2_0034596-US_PP_NOAA2_0034614
US_PP_NOAA2_0045008-US_PP_NOAA2_0045020
US_PP_NOAA2_0047061-US_PP_NOAA2_0047067
US_PP_NOAA2_0065245-US_PP_NOAA2_0065252
US_PP_NOAA2_0087360-US_PP_NOAA2_0087368
US_PP_RICE003288-US_PP_RICE003295
US_PP_RICE004320-US_PP_RICE004333