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

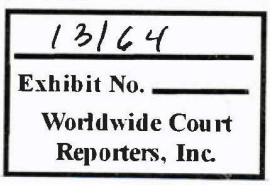
Rebuttal Report to the Expert Reports of:

Donald F. Boesch and Stanley D. Rice

In Re Oil Spill by the Oil Rig "*Deepwater Horizon*" in the Gulf of Mexico, on April 20, 2010
MDL 2179
U.S. District Court for the Eastern District of Louisiana

September 12, 2014

Dr. John W. Tunnell, Jr.



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Introduction

The United States' environmental experts – Drs. Donald Boesch and Stanley Rice – opine about potential environmental harm from the *Deepwater Horizon* incident by focusing on laboratory studies and hypothetical impacts (including models), while largely ignoring the massive quantity of actual, real-world data in the Gulf of Mexico. After reviewing Drs. Boesch and Rice's reports carefully, it remains my opinion that there were no significant adverse impacts to fish, shellfish, and bird populations in the northern Gulf of Mexico as a result of the *Deepwater Horizon* oil spill, nor is there any evidence of significant or large-scale impacts to deep-sea corals, sea turtles, or dolphins. My opinions on the current status and historical trends of northern Gulf of Mexico populations still stand as reported in my submitted Expert Report, and these opinions have not changed.

Drs. Boesch and Rice present a variety of issues and concerns regarding numerous habitats and species. Interestingly, in most cases, Drs. Boesch and Rice do not actually conclude that there was environmental harm to Gulf of Mexico wildlife or fish populations from the spill, but instead speak of "potential" harm. For purposes of this Round Two Report, I will not address each and every aspect of their reports, but instead I will comment on the following six categories raised by Drs. Boesch or Rice:

i. Deep-water Corals
ii. Sea Turtles
iii. Birds
iv. Dolphins
v. Environmental Lessons from Other Spills (e.g., *Exxon Valdez* and *Ixtoc I*)
vi. Fish and Shellfish

Studies Relied Upon by the United States Demonstrate that the Vast Majority of Deep-water Corals Were Never Affected by the Spill

1. **Corals are animals attached to the sea floor**. Before addressing the specifics of Drs. Boesch and Rice related to corals, it is important to understand what corals are and what they are not.[1] Corals are simple, primitive animals found in the same group (phylum) as jelly fish and sea anemones. Unlike these other animals, however, most corals are colonial, which means that there are multiple individuals living together in the same colony. Many shallow-water corals are known as hard or stony corals because they can secrete skeletons that form coral reefs, the largest living structures on earth (*e.g.*, Great Barrier Reef in Australia). Although a few deep-water corals have small hard skeletons, most of them are known as soft corals because they do not have a stony, or calcium carbonate (limestone), skeleton. The octocorals, the primary group discussed here, are soft corals that live in shallow water and deep water, and they

[1] In addition to my qualifications set forth in my opening Expert Report, it is worth noting that I have studied coral reefs in the Gulf of Mexico for over 40 years, focusing on shallow-water reefs. I have published many scientific papers and one book on the coral reefs of Mexico in the southern Gulf of Mexico, and I served on the Ph.D. advisory committee of Peter Etnoyer mentioned below in this section.

possess a firm, rod-like skeleton internally to give them structure and support. A single coral with many individuals is called a colony, and a group of these individual colonies growing together in one area is called a coral community.

2. **The vast majority of deep-water coral communities were not affected by the *Deepwater Horizon*.** Both Drs. Boesch and Rice discuss published articles that conclude that selected deep-water coral colonies and communities were potentially impacted by the *Deepwater Horizon* spill. However, as one of these articles notes, "most known deep-water coral communities in the Gulf of Mexico do not appear to have been acutely impacted by the spill" (Fisher et al. 2014a).[2]

3. **Of the thousands of coral colonies observed by Fisher et al. (2014a), only a small number were affected.** In October 2010, just after the *Deepwater Horizon* spill, Fisher and colleagues visited 13 formerly known deep-water coral sites spread over a depth range of 350-2,600 meters and "did not detect visual indications of acute effects to coral communities at any of these sites" (Fisher et al. 2014a). Subsequently, after discovering a new coral community site 13 km from the wellhead in November 2010 (Site MC294; White et al. 2012, Hsing et al. 2013), Fisher and colleagues planned to return and look for more new, unknown sites that might have been affected. Utilizing Bureau of Ocean and Energy Management (BOEM) data, the Fisher team revealed 488 potential sites for corals, and then narrowed that selection to a subset of 29 representing multiple areas in different directions from the wellhead. Fisher et al. (2014a) presents data on ten sites (Fisher et al. 2014a, Table 1). Fisher et al. reported that except for two sites, the new sites surveyed "did not show visible evidence of acute recent impact to the colonial coral communities" (Fisher et al. 2014a).[3] Fisher and his team also revisited previously known sites which "each harbor thousands of coral colonies." Importantly, Fisher et al. reported that these re-visited sites "continued to show no visible signs of recent impact."[4]

4. **To the extent there was some limited harm caused by the *Deepwater Horizon*, evidence of recovery is apparent in the Fisher et al. (2014a) data.** Examination of Figure 4 from Fisher et al. (2014a) shows the same coral colony at MC294 in 2010 (Figure 4A) and 2011 (Figure 4B), and growth or recovery of live yellow coral tissue is evident in several places on the 2011 image compared to the 2010 image (Figure 1). In addition, in their most recent paper, Fisher et al. (2014b) state that "colonies observed with low levels of floc on their surface in 2010 (less than 20% coverage) were likely to exhibit apparently complete recovery of the floc-covered

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[2] Although deepwater corals are sparsely distributed in the area near the MC252 wellhead (*see, e.g.*, Fisher 2014a, Figure 2), these corals are otherwise wide-ranging, abundant, and diverse throughout the Gulf. Appendix A discusses the distribution of deepwater corals in the northern Gulf of Mexico.

[3] Even in the small number of instances where Fisher et al. (2014a) observe impact, they report this impact on the individual colony level rather than community level, thereby further demonstrating the limited nature of the observed impact. As stated above, multiple coral colonies make up a coral community. Moreover, of the colonies described in the article, only two are clearly identified in the supplemental information as affected in their entirety with damage attributed by Fisher et al.(2014a) to the spill, and most were recorded as partially damaged, many as low as 1%, 2%, or less than 5% (Fisher et al. 2014a, Table S1).

[4] Interestingly, Fisher and his team also found coral community sites with evidence of fishing gear damage or impact, and they are developing a new line of research using corals as biomonitors or indicators of anthropogenic impact to the deep-sea (Fisher et al. 2014b).

branches by March 2012." Moreover, the above impacts are small in perspective when compared with the impact from a single deep-sea trawler that could significantly damage all three of these reported coral community sites entirely in just a single day with no chance of recovery (Watling and Norse 1998, Jackson 2001, Hall-Spencer et al. 2002, Stiles et al. 2007, Clark et al. 2010). When corals are ripped from the bottom during trawling, they will die, but when they are only partially damaged and still attached to the bottom, they have the opportunity to recover, especially if only a small portion of the colony is affected, as noted by Hsing et al (2013) and Fisher et al. (2014a).

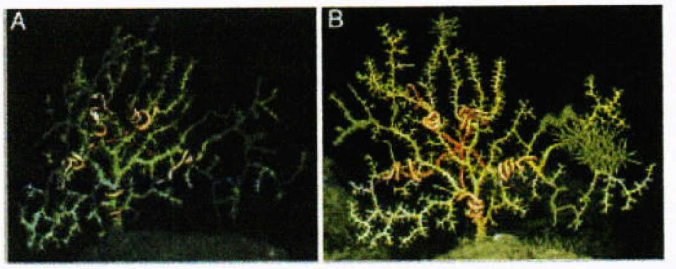

Figure 1 – This is Figure 4 from Fisher et al. (2014a) showing a coral colony at MC294 in November 2010 (A) and one year later in November 2011 (B). Note the extended polyps and apparently healthy yellow tissue on most branches in November 2011.

5. **Observed coral impacts could be caused by natural seeps, not the *Deepwater Horizon*.** There is a very active seep area around Dauphin Dome in the southeastern corner of lease block MC344.[5] This site with numerous natural seeps is where Fisher et al. (2014a and b) found coral colonies that they say are impacted by *Deepwater Horizon* oil. This natural seep activity is even noted by Fisher et al. (2014b). Accordingly, impacts observed by Fisher could be the result of natural seeps and not oil from the *Deepwater Horizon* spill.[6]

Data Show Very Limited Harm to Sea Turtles and Near 100% Recovery of Those Turtles that Were Oiled

6. **Actual harm to turtles from the oil spill was much lower than Dr. Boesch implies.** Dr. Boesch states that "[s]ea turtles suffered substantial mortalities and unusually high rates of stranding that have continued through at least 2013" (Boesch Report, p.19). However, of the 618 sea turtles listed in the "DWH Response Consolidated Fish and Wildlife Collection Report" as "Collected Dead," only 18 were "Visibly Oiled" (Exhibit 12078, McNulty deposition,

[5] NOAA R/V *Okeanos Explorer* cruise to Gulf of Mexico to explore and map natural hydrocarbon seeps (slide 16), *available at* http://www.mmri.olemiss.edu/Renderers/ShowMedia.ashx?id=8e4f7080-ef9f-491d-b832-8a800f29f215.

[6] NOAA cruises in this area in 2012 also found tubeworms, indicators of areas of active hydrocarbon seeps. http://docs.lib.noaa.gov/OEDV/Okeanos_Explorer_2012_EX1202/Leg_2/image/EX1202L2_DIVE13_20120402/EX1202L2_IMG_20120402T154619Z_ROVHD_M2_4.jpg; http://docs.lib.noaa.gov/OEDV/Okeanos_Explorer_2012_EX1202/Leg_2/video/EX1202L2_DIVE13_20120402/. Information on the 2012 NOAA cruises is available at the cruise website at http://oceanexplorer.noaa.gov/okeanos/explorations/ex1202/welcome.html.

p.54, line 19, July 1, 2014). Moreover, the fact that 18 turtles were oiled does not suggest that these turtles died from oiling. Oiling status in these observations was not intended to (and does not) indicate the cause of death. (McNulty deposition, p.68, lines 1-4; "Status of oiling was not meant to indicate the cause of stranding or the cause of death for any of these animals."). Neither does the oiling status category indicate whether oiling occurred before or after the turtles died.

7. **The United States has already stated that most "collected dead" sea turtles were *not* killed by oil.** Many of the sea turtles collected during the spill died by drowning in shrimp trawling nets (Exhibits 12080 and 12087, McNulty deposition). This cause of mortality was verified by NOAA's veterinarian Dr. Brian Stacy (Exhibit 12087, McNulty deposition, p. 147, lines 12-17). The extent of this cause of sea turtle mortality was described by NOAA Administrator Dr. Jane Lubchenco: "to our surprise, most of the dead stranded sea turtles had no observable oil on their bodies and were in good health prior to their death" and that "[n]ecropsies (autopsies on animals) on more than half of 600 carcasses point to the possibility that a majority may have drowned in fishing gear" (Exhibit 12080, McNulty deposition, p.142, lines 11-14).

8. **Moreover, *nearly all* of the sea turtles collected alive during the spill were determined to be healthy and subsequently released.** Dr. Boesch states correctly that "[o]ver one thousand sea turtles were collected in the Deepwater Horizon Response" (Boesch, p.19). Of those collected alive, most (456 out of 536) were categorized as visibly oiled, but Dr. Boesch does not mention that "more than 96% survived" (Exhibit 12080) and most were released back into the wild (McNulty deposition, pp.74-75; Exhibit 12078). In other words, even of those turtles categorized as visibly oiled, the vast majority was determined to be healthy following rehabilitation, and they were subsequently released. In addition to these released sea turtles, over 14,000 sea turtle hatchlings were also released in a U.S. Fish and Wildlife Service program to relocate eggs from sea turtle nests in the northern Gulf of Mexico and release them in the Atlantic Ocean (McNulty deposition, pp.165-168).

9. **Increased human presence during the spill response led to higher observations of sea turtle strandings compared to previous years.** The comparison of sea turtles collected during or after the spill to pre-spill numbers is misleading and scientifically inaccurate. The government-sponsored effort to locate and collect stranded animals was "significantly augmented" during the response phase, and this "increased capacity enhanced detection, response, and rehabilitation capabilities across the four states of the upper Gulf of Mexico" (Exhibit 12081, p.168; McNulty deposition, p.174 & p.188, lines 3-6).[7] In addition, there was "an increase in awareness and human presence in the northern Gulf of Mexico, which likely has resulted in some of the increased documentation of stranded turtles since the inception of the oil spill" (Exhibit 12084, p.3, top), and there was a public wildlife hotline to report strandings (McNulty deposition, pp.130-131). Accordingly, the numbers of sea turtles and marine mammals reported after the oil spill resulted in part from the increased search for these animals not an increased occurrence of mortality. So, the comparison between pre-spill years (1986-2007) to the spill year (2010) by Dr. Boesch in his Figure 5 is not appropriate without

[7] Similar statements enforcing this concept are also found in the Federal Register (Exhibit 12083, McNulty deposition) and on the Consolidated Report (Exhibit 12078, McNulty deposition) instructions or guidelines.

taking into account this very important fact of enhanced detection with far more observers than any previous year, and augmentation by people in boats and planes.

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

10. **Unlike models of projected or potential harm, actual harm was limited to mortality of selected birds in the summer of 2010, and there is no indication of any significant or long-term population impacts.** Dr. Boesch states in his report that "[a]ctual bird mortalities were substantially greater than the number of carcasses collected and potentially depleted populations of some bird species in the northern Gulf of Mexico" (Boesch Report, p.38). These strong claims are unsubstantiated, and they are not supported in data I analyzed and presented in my Expert Report from northern Gulf of Mexico Christmas Bird Counts and Breeding Bird Survey counts. Dr. Boesch's claims are not supported by any data presented in his expert report.

11. **Dr. Boesch rests the majority of his claims of "potential harm" to birds on two models in a "forthcoming journal article."** This paper is not publically available and Dr. Boesch appears to rely on the published abstract and information contained in a *New York Times* article only (Boesch Report p.38). However, if the reported conclusions from this forthcoming article were accurate, and the spill caused the mortality of hundreds of thousands to millions of birds, such mortality should show up in post-spill bird population surveys. As explained in my opening Expert Report, these bird population surveys do not show such mortality.

12. The *New York Times* article describes a forthcoming publication that I have not seen, and apparently Dr. Boesch has not seen it either. Based upon the abstract, however, it is likely that this *New York Times* reported study relies upon something called a "beached bird model." Beached bird models are used to account for birds that may have been killed by an oil spill but not observed due to predation, sinking, or other reasons.[8]

13. One input that is necessary for beached bird models is "searcher efficiency" ("quantification of an ability of search teams to find a carcass when searching for it. Another way of describing that is carcass detection rate." Higgins deposition p.39, lines 9-12). Dr. Higgins agreed that "[b]ecause carcass-detection rates are variable, dependent upon a range of local factors . . . it is important to document detection rates on a site-specific basis." (p.67, line

[8] The beached bird model was developed by G.W. Page and Glenn Ford (Page et al. 1990) and has been applied in a number oil spills in California (*e.g.*, Ford et al. 1987, 2006, 2009, as examples). In his deposition, the United States witness Dr. Damian Higgins explained that "beached bird models" are "a methodology intended to estimate bird mortality related to an oil spill" that "works by assessing or making assumptions regarding data that's -- using data that's collected, specifically number of birds that are encountered during searches, also trying to account for birds that are not found during searches with various different parameters." (Higgins deposition p.35, line 18 - p.36, line 1).

25 - p.68 line 8). Dr. Boesch does not appear to use site specific data to determine searcher efficiency even though these data are available to the United States.[9]

14. Another input to beached bird models is an estimate of "carcass persistence," or "a description of when a carcass is laid on -- in a particular area that's being searched, how long it may persist before its being found" (Higgins deposition p. 40, line 23 - p. 41, line 1). Dr. Higgins also agreed that carcass persistence can also vary dependent on "site-specific factors" such as habitat, abundance of scavengers, season, weather, and tidal conditions (pp. 79-80). He also stated that "[p]ersistence rates have varied widely from oil spill to oil spill, depending upon geography and some of the factors we've already discussed" (p. 92, lines 9-11). Dr. Boesch does not appear to use site specific data to determine carcass persistence rates even though these data are available to the United States.[10]

15. Another input to the beached bird model is an estimate of how likely a bird that dies at sea would sink before reaching shore (pp. 93-94). This estimate is also dependent on "site-specific conditions" according to Dr. Higgins, including bird size, water temperature, and tidal conditions (p. 94). Dr. Boesch does not appear to use site specific data to determine sinking rates even though these data are available to the United States.[11]

16. Neither the *New York Times* article, nor the abstract of the Haney et al. study available online, indicates how the authors determined these critical inputs into their model. Without more information regarding the detection rates and carcass persistence rates used in the forthcoming article, and how the authors determined the local and regional site-specific factors, it is impossible for Dr. Boesch to rely on the outcome of the model. Had Dr. Boesch utilized site specific data to model actual bird mortality, the results necessarily would have been significantly lower, in line with the population data.

17. As noted in my Report, there was limited impact and mortality to selected birds in the summer of 2010, but after that there is no indication of any significant adverse impact to bird populations in the northern Gulf. The population trends after the spill are similar to those trends before the spill. In addition, as discussed in my Report, NRDA observational data on the oiling rate, number, and percentage of oiled and non-oiled birds during and after the *Deepwater Horizon* oil spill (May 2010 through March 2011) show that 447,618 birds were observed, and of that number 99.33% had no visible oil on them. In sum, the evidence I have reviewed simply does not support the figures of bird mortality advanced in Dr. Boesch's report.

Increased Dolphin Strandings Began Before the Spill; Data do Not Indicate a Spill-Related Impact to Dolphins

18. **According to NOAA, increased dolphin strandings began in February 2010.** NOAA declares "Unusual Mortality Events" (UMEs) for marine mammals when it notices a higher than normal percentage of stranded or beached animals over a period of time. In

[9] Higgins deposition, p.76, line 8, searcher efficiency data in Exhibit 12608.

[10] Higgins deposition, p. 86, line 25, persistence rate data in Exhibit 12611.

[11] Higgins deposition, p. 100, line 11, sinking rate data in Exhibit 12614.

December 2010, NOAA retroactively declared a UME for cetaceans (including bottlenose dolphins) in the Gulf of Mexico beginning in February 2010.[12]

19. **NOAA set the beginning of this UME at February 2010, nearly three months before the spill began.** In his report, however, Dr. Boesch states that the UME occurred "around the time of and subsequent to the blowout" (Boesch Report, p.39). This description of the timing of the UME completely ignores the significant pre-spill strandings that caused NOAA to set the start of the UME in February 2010 before the spill.

20. **UMEs are not actually unusual**. UMEs that involve bottlenose dolphins are fairly frequent in the past two decades.[13] NOAA often determines that biotoxins (poisons produced by living organisms, such as the algae that cause red tide), infectious diseases, or ecological factors are the cause of a particular UME, but the cause for a large proportion of UMEs remains undetermined.[14]

21. **There are many likely causes for dolphin mortality in the Gulf unrelated to the oil spill**. Dr. Boesch himself acknowledges the cold winter of 2010 as a potential cause of strandings related to neonatal dolphins (Boesch, p.39). In addition, the infectious disease brucellosis has also been identified in bottlenose dolphins in Louisiana, Mississippi, and Alabama. Brucellosis can cause sickness and death and is now known to have caused the deaths of almost one-third (53 of 173) of the dolphins that were tested in the UME (Exhibit 12097, McNulty deposition, pp.227-230). Of the dolphins collected during the spill and described in the Consolidated Fish and Wildlife Collection Report, only 2 live dolphins and 10 dead dolphins were listed as visibly oiled (Exhibit 12078).

22. **The medical records provided by NOAA do not indicate that even a single dolphin died because of the oil spill**. As an ecologist, a scientist who studies the organisms and the environment in which they live, I reviewed the United States' medical records of 130 bottlenose dolphins collected along the northern Gulf of Mexico shores from April 20, 2010 to May 30, 2011. Not a single animal of any of these 130 examined by veterinarians were categorized as having "Cause of Death" listed as being caused by the oil spill. Conversely, numerous other causes of death – unrelated to oil – were indicated, including:

a. Brucellosis
b. Gunshot wounds
c. String ray barbs
d. Asphyxiation
e. Blunt force trauma
f. Stillborn
g. Pneumonia

[12] http://www.nmfs.noaa.gov/pr/health/mmume/cetacean_gulfofmexico.htm.

[13] http://www.nmfs.noaa.gov/pr/health/mmume/.

[14] http://www.nmfs.noaa.gov/pr/pdfs/health/ume_causes_years.pdf. The government has been unable to identify causes of 31 of 60 documented UMEs.

h. Hemorrhagic syndrome

i. Diseases including bacterial meningitis, possible encephalitis, pleuritis, or peritonitis.

23. **There may not have been a UME during the spill.** As with turtles, increased search effort during and since the spill very likely influenced the stranding data. As the United States' own witness has testified: "Based on my experience, the more people that are in the environment, walking a beach, or on vessels nearshore or offshore, the greater likelihood you would have of identifying a sea turtle or marine mammal or any other type of wildlife that might be stranded in that area" (McNulty deposition at p.121, lines 13-19). In addition, Sara McNulty also states that "If a member of the public saw a stranded [animal], they might not have otherwise known who to call or how to report it. And due to this increased awareness and the advertisement of the wildlife hotline, they may have been more likely to report the animal because they knew where to report it to."(McNulty deposition, p.130, line 24 to p.131, line 6).

24. **Dr. Boesch's suggestion of dolphins breathing fumes is unsupported and highly unlikely.** Dr. Boesch states that Barataria Bay bottlenose dolphins "had been breathing oil fumes at the water's surface" (p.39), but oil reaching Barataria Bay – and any oil that had been on the surface of the Gulf for any extended period of time – was highly weathered and is unlikely to have posed an inhalation risk. Dr. Boesch does not present any evidence to the contrary.

25. **The Barataria Bay dolphin study is questionable.** Finally, Dr. Boesch refers to a published paper by Schwacke et al. (2014) on bottlenose dolphin health in Barataria Bay, Louisiana (Boesch p.39). There are reasons to doubt this study.[15] For example, the United States' own witness, Dr. Amy Merten, testified to an important discrepancy in this published paper (Schwacke et al. 2014) when compared to the corresponding field forms taken by the NOAA research team for this NRDA work plan (Exhibit 11771, Merten deposition, p.126; Figure 1 of Schwacke et al. (2014), Exhibit 11772, Merten deposition, pp.139-149). Schwacke reports that five dolphins in Barataria Bay were significantly underweight. However, Dr. Schwacke herself observed that 3 of these 5 dolphins (60%) were actually in ideal condition when observed in the field.[16] In addition, Schwacke's comparison of the Barataria Bay dolphin population to Sarasota Bay is inappropriate for many reasons, including the fact that Barataria Bay is a far more contaminated and compromised environment (unrelated to the *Deepwater Horizon* oil spill) than Sarasota bay.[17]

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[15] *See, e.g.*, Lucinda A. Jacobs. Comment on Health of Common Bottlenose Dolphins (*Tursiops truncatus*) in Barataria Bay, Louisiana, Following the *Deepwater Horizon* Oil Spill. Environmental Science & Technology (2014).

[16] Three of these 5 dolphins, as identified by a specific Freeze-Brand Identifier number on their dorsal fin and on the hand-written field forms (Exhibit 11773, Merten deposition, p. 144) during this project are listed under their "Physical Exam, Item 2-Body condition index (p. 3)" as "Ideal."

[17] Merten deposition, pp.149-150. In addition, researchers are much more likely to capture sick dolphins in Barataria Bay than Sarasota Bay, where healthy dolphins are familiar with researchers; Merten deposition, pp.138-139.

The United States Experts Misconstrue the Lessons from the *Exxon Valdez* and *Ixtoc* Oil Spills

26. Both Drs. Rice and Boesch look to other spills – principally the *Exxon Valdez* and *Ixtoc* spills – for indications of the actual and potential environmental effects from the *Deepwater Horizon* incident. They overstate the relevance of the *Exxon Valdez* for the Gulf of Mexico, which has a different climate, different spill conditions, and a different ecosystem from Prince William Sound. Furthermore, Drs. Rice and Boesch ignore the evidence of recovery from the *Ixtoc I* spill, which occurred here in the Gulf of Mexico over a greater time frame and with a larger application of dispersants than the *Deepwater Horizon* spill (Jernelöv and Lindén 1981).

27. **After two decades of research, scientists have found no causal link between the Prince William Sound Pacific herring crash to the *Exxon Valdez* spill.** Both Drs. Boesch and Rice mention the crash of the herring fishery in Prince William Sound (PWS) four years after the *Exxon Valdez* oil spill as evidence of potential future impacts in the Gulf of Mexico.[18] However, even Dr. Rice acknowledges that the herring collapse in the years following the *Exxon Valdez* oil spill "has never been explained satisfactorily" (Rice Expert Report, p.17; Rice and Carls 2007). Many scientists, after far-reaching studies of this highly complex dilemma, have concluded "that there was no connection between the spill and the herring decline" and further note that "that natural and other anthropogenic factors overwhelmed any effects of the *Exxon Valdez* oil spill on the population dynamics of the PWS herring" (Pearson et al. 2013).

28. **The 1979-1980 *Ixtoc I* oil spill was widespread in the southern Gulf of Mexico but the environment recovered quickly.** The *Ixtoc I* blowout in the southern Gulf of Mexico released oil for 9.7 months over all four seasons of the year (June 3, 1979, to March 23, 1980), pushing floating oil with changing seasonal winds in all different directions and all around the southern Gulf. Although some impacts were recorded in the literature to selected habitats and species, as noted by Dr. Rice in his report, full recovery to most habitats and species was documented in 1 to 3 years (shorebirds, Chapman 1981, 1984; Texas beaches, Tunnell et al. 1981, Kindinger 1981, Vega 1988; Mexico shrimp, Soto et al. 1981). A Bureau of Land Management report concluded that post-spill changes on the Texas coast were due to natural variability, not to effects from the *Ixtoc I* spill (ERCO 1982). In addition, on the South Texas continental shelf where considerable *Ixtoc I* oil was present on the surface, there were no *Ixtoc I* oil residues found in sediments of the shrimp grounds (Lewbel 1985), and an examination of Texas Commercial Harvest Statistics revealed no significant change in shrimp catches after the spill (Hamilton 1983). [19]

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[18] I also referenced this example in my Expert Opinion on the potential recovery timeframe for the *Deepwater Horizon* oil spill (Tunnell 2011). However, upon review of the latest scientific literature (including Rice and Carls 2007), I believe reference to the Pacific Herring collapse is inapplicable.

[19] The largest oil spill in history occurred in the Arabian Gulf region when approximately 520 million gallons of crude oil was released during the Iraq-Kuwait conflict (Tawfig and Olsen 1993). Although there were significant shoreline impacts to marshes and intertidal habitats (Gundlach et at. 1993, Jones et al. 1996), there were no significant long-term impacts to subtidal habitats or communities, including seagrass meadows, coral patch and fringing reefs, unvegetated sandy and silty substrates, and rocky outcrops (Kenworthy et al. 1993, Richmond 1996). Likewise, shrimp stocks that were initially impacted with drastic drops in spawning and total biomass (Matthews et al. 1993), rebounded in a few years to "better than anyone could remember that it had ever been" (Jernelöv 2010).

The United States Does Not Provide Evidence of Adverse Effects to Fish and Shellfish Populations

29. Dr. Boesch references potential harm to fish and shellfish populations in some parts of his report, but he provides no evidence of such harm, and he does not review the actual population data. A recently published study (Fodrie et al. 2014) surveys the literature to date on estuarine fishes related to the incident and finds "an absence of measurable negative impacts among populations." Fodrie et al. (2014) highlight the need to put studies that suggest effects on individuals into the context of the ecosystem, and to look at data that can help assess the conditions of populations, as I have done in my Expert Report.

30. Dr. Boesch appears to agree with me on the lack of any evidence that oil harmed oysters ("I am unaware of any reports, scientific or otherwise, of Macondo oil directly killing oysters." Boesch Report, p.36).

31. The reports of Drs. Boesch and Rice have not caused me to alter my previously stated opinion with respect to fish and shellfish. Dr. Boesch, and particularly Dr. Rice, put too much emphasis on ecotoxicology studies rather than the real-world data of fish and shellfish populations in the Gulf of Mexico. While ecotoxicology studies may be potentially useful to the development of new science, they do not reflect how the populations of the Gulf of Mexico are doing in their natural habitats.

Conclusion

32. After reviewing the expert reports of Drs. Donald Boesch and Stanley Rice, I conclude to a reasonable degree of scientific certainty that the environmental harm from the *Deepwater Horizon* oil spill was limited and the Gulf of Mexico has largely recovered. An objective evaluation of environmental harm should, in my opinion, be based on data, and the environmental data indicate that the oil spill generally did not cause any significant adverse harm to habitats and animal populations. In addition, I do not expect to see any such effects in the future.

33. As explained above and in my original report, impacts from the spill to deep-sea corals, birds, fish, shellfish, sea turtles, and dolphins in the Gulf of Mexico were limited. The United States' environmental experts have presented no actual evidence or data to indicate impacts to the populations of any of these animals.

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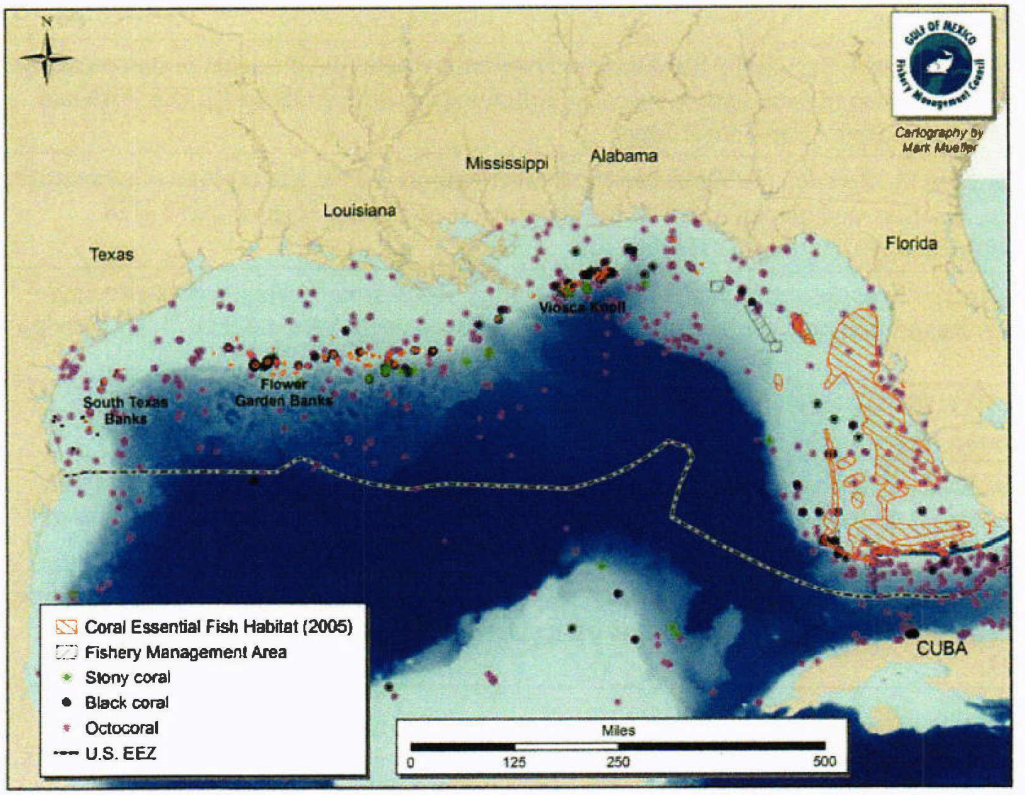
Appendix A - Abundance and Diversity of Deep Water Coral in the Gulf of Mexico

Etnoyer (2009) compiled a database of 1,881 unique records of octocorals from the entire Gulf of Mexico contained in five museums (*e.g.*, U.S. National Museum of Natural History, Harvard University Museum of Comparative Zoology), the Minerals Management Service (now Bureau of Ocean Energy Management), and one large specific study (Giammona 1978). Most of the 1,881 records are from the northern Gulf, and a significant number are from the deep-sea, extending from the far western Gulf through the Florida Straits in the east. Etnoyer (2009) concluded that "octocorals are rich, diverse, and presumably abundant in the deep Gulf of Mexico." In addition, a recent taxonomic inventory of octocorals living in the Gulf of Mexico listed a total of 162 species, of which 113 or 77% are from the deep Gulf (>200m) (Cairns and Bayer 2009).



This is Figure 4.3.1 from GMFMC (2013) showing Coral Essential Fish Habitat and Fishery Management Areas, as well as stony coral, black coral, and octocoral distribution in the Gulf of Mexico. The pink dots represent distribution of octocorals by Etnoyer (2009).

Appendix B: Consideration Material List

Document Title / Description
Boesch, D.F. 2014. Actual and potential harm from the Macondo Well blowout. Submitted on Behalf of the United States in the case U.S. v. BP Exploration & Production, Inc. et al. 69pp.
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